An evaluation of Feuerstein's model for the remediation of adolescents' cognitive deficits.

Beasley, Frances Patricia

AN EVALUATION OF FEUERSTEIN'S MODEL FOR THE REMEDIATION OF ADOLESCENTS' COGNITIVE DEFICITS

FRANCES PATRICIA BEASLEY

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ABSTRACT

Feuerstein's intervention programme, Instrumental Enrichment (IE), occupies a unique place in the literature of intervention studies in that it is applied to adolescents and has a rich underlying model. Yet previous evaluations have only assessed pupil achievement and one of the seven parameters named in Feuerstein's model (mental abilities). This study set out to assess two more of the parameters: those of cognitive Operations and of Phase (deficient cognitive functions). To assess the latter Feuerstein's clinical interview methodology, the Learning Potential Assessment Device (LPAD), was developed further to make it yield quantitative estimates.

Ten retarded adolescents, from a class of twenty, received IE for eighteen months. Their pre- to post-test changes in performance were compared with the remaining pupils on Piagetian, psychometric, school achievement and LPAD measures.

The experimental group had improved substantially on tests of "fluid" intelligence: on a Piagetian battery there was a mean difference of 1.22 standard deviations (sd) between the improvements of the two groups; and 1.07 sd on Raven's matrices. In addition, the experimental group demonstrated more sophisticated use of the cognitive functions (an effect size of 0.72 sd), and were also more consistent on these behaviours. While in one sense these results can be interpreted as indicating an increase in the 'modifiability' of the IE pupils (as Feuerstein predicts), a direct test of 'modifiability', the LPAD, showed no consistent differences between groups. There were also no significant differences on measures of mental abilities (Thurstone's PMA) or on tests of school achievement.

It appears that IE can be validated in terms of its own cognitive model but that further clarification of the model may be necessary

before the principles can be extracted and applied as a general intervention strategy. LPAD has proved to be a better detector than predictor of the effects of IE intervention.

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CHAPTER ONE

THE LITERATURE REVIEW

INTRODUCTION TO THE LITERATURE

The term mental retardation has come to imply an irreversible state in which the capacity of the individual for cognitive growth is regarded as minimal. It is the contention here that, except in the most severe cases of organic impairment, the human organism is open to change even at relatively late stages of development. Reuven Feuerstein's work, both on the assessment and training of retarded adolescents, underscores the belief in the power of intervention to effect meaningful changes in the level of cognitive functioning for these individuals.

Feuerstein offers a unique "learning to learn" approach to the remediation of the cognitive deficits which he maintains are responsible for poor intellectual performance. His intervention programme, Instrumental Enrichment (IE), is based on the same cognitive model as his dynamic approach to the assessment of retarded individuals: the Learning Potential Assessment Device (LPAD). The following review attempts to set Feuerstein's work within the context of other psychological literature.

For convenience the issues raised by the assessment and training of low-functioning individuals will be introduced separately. The literature is divided into four parts. Part 1 concerns matters which are pertinent to intervention studies in general, whilst Part 2 deals specifically with Feuerstein's own programme (IE) and his rationale for cognitive modifiability. Part 3 describes the current state of disaffection with conventional psychometric tests and learning ability tasks are suggested as an alternative. Feuerstein's LPAD technique, discussed in Part 4, is based on this approach.

PART 1: INTERVENTION ISSUES

NATURE/NURTURE: A BACKCLOTH FOR INTERVENTION STUDIES

Theories of intelligence vary profoundly in their emphasis on different determinants of performance, ranging from a heavy hereditarian perspective to an exigent environmental one. Of particular moment is the degree to which modifications in the course of growth are deemed to be possible. The implications of subscribing to either of these main-effects models of development can be extremely political, particularly where intervention studies are concerned; they dictate both the nature and the intensity of the commitment to change. If one accepts a high heritability estimate (assuming intelligence to be largely innate) then there may be a temptation to view all low-IQ children as low achievers rather than as under achievers: a philosophy which is reflected in educational provision.

A vast and rapidly expanding literature has been dedicated to estimating the contributions of genetic endowment and environmental background on performance. Yet despite increasingly sophisticated techniques we are still a long way short of understanding the complex transactional effects between man, his personality and the environment. For many families, environmental circumstances tend to remain relatively constant and this might add to the resemblances which are generally accounted for by genes (Vernon 1977). We are warned by Plomin (1983) against presuming that longitudinally stable characteristics are always genetic and that genetically influenced characteristics are always stable across time.

Even if one accepts a large heritability estimate this does not mean that IQ's are fixed for all individuals for all time. A.R.Jensen, whose views on inheritance have been well publicised, has recently commented that even with a heritability estimate as large as .7 or .8, the range of environmental influence may still be as much as 45 IQ points (Jensen 1981)!

There is no need to share in the pessimistic predictions of earlier 'constancy' models that human development is fixed; for reasons of the genetic inheritance of intelligence (Spearman 1904), or as a consequence of the formative role of the early environment on the affective development of the individual (Freud 1938 trans. 1949, Watson 1928). Genetic and environmental influences may unfold in a non-linear fashion and Clarke and Clarke (1984) have argued that both developmental continuities and discontinuities are important factors affecting the growth of human characteristics. Previously Alan Clarke has suggested that this implies to some extent a potential open-endedness in human development (Clarke 1978).

The human organism has been furnished with both a degree of constancy and the potential to change with fluctuating circumstances, good or bad. Whilst it might be the case that this 'plasticity' wanes with time, the average individual response to major environmental shift can be considerable (Clarke & Clarke 1976). Studies of children rescued from conditions of adversity are a testament to this. Ann Clarke postulates the existence of a biological trajectory: a broad course of development from which individuals will deviate in conditions of extreme adversity, but to which they will return once the stresses are removed or diminished. (Likewise, a social trajectory may operate). Thus the possibility for recovery exists for those whose level of functioning has been markedly depressed by social conditions (Clarke 1984).

Intervention effort need not, as was previously thought, be initiated at a very early age for it to be effective (to be discussed in more detail). The development of intelligence is known to continue into early adolescence; moreover, recent studies, conducted from a life-span developmental perspective, have challenged the inevitability of the decline in later years (Baltes & Schaie 1976). Both Piagetian and metacognitive theorists posit a qualitative shift in the nature of intelligence when the individual reaches adolescence (Inhelder & Piaget 1958, Wiens 1983). As a child's awareness of his own and other people's thinking processes emerges his cognition can now be modified with his consent and cooperation. Thus, far from being an end to sensitivity, adolescence may offer a second chance for cognitive redevelopment (Hobbs & Robinson 1982). Feuerstein's Instrumental Enrichment programme, to be discussed in Part 2 of this review, offers this second chance to retarded adolescents.

The nature/nurture debate has often generated more heat than light. Perhaps we have been asking the wrong questions: instead of focusing on the proportion of phenotypic expression attributable to genetic causes, it may be of more practical use to know how far they can be modified by environmental experience. Admitting the importance of genetic potentialities for any kind of intellectual growth should not prevent fruitful investigations of how to stimulate certain kinds of achievement. The social prognosis for the majority of mildly retarded people is good; a high proportion are satisfactorily absorbed into society once they reach adulthood (Clarke 1977). It is encouraging that this disposition to move towards the mean occurs naturally, however, it is not in itself a reason for not attempting to accelerate and improve the 'absorption' process.

CRITICAL PERIODS FOR DEVELOPMENT

The increasing recognition of the importance of environmental factors for healthy cognitive development led to the birth of the popular intervention movement in the 1960's. Unfortunately, with it came the view that intervention would only be effective in the early years. Up until the last ten years the 'critical periods' notion appeared invulnerable to criticism. The weight of more recent evidence concerning the developmental potential for change, even amongst older children and adults, has forced us to rethink this tenaciously held view (Thomas 1981).

The critical or sensitive periods notion was borrowed directly from comparative and ethological studies, although it may not have been appropriate to do so. The literature, which has been summarised by Hunt (1979), concerns vast amounts of experimental work with animals on the role of early learning and imprinting. There is a great difference, however, between the early impressionable learning of ducklings, who for survival reasons follow almost everything that moves within a narrowly specified time limit, and the gradual intricate development of human learning. Human and animal intelligence is not the same. According to Cattell (1971) lower-order animals may act purposively, their behaviour results from the genetic trial-and-error learning of phylogenetic evolution, but man acts purposefully, that is with insight. The lack of a complete hereditary prescription permits a high degree of flexibility in the way man responds to changing circumstance.

Furthermore, animal studies have failed to show the timing of adverse experience to be all important. The consequences of isolation may be pervasive whenever it occurs, yet, in the few studies which have attempted to overcome the effects of early trauma in animals (for example, Novak & Harlow 1975) the consensus is a reversion towards normality.

It was John Bowlby who applied this 'critical periods' notion to human development (Bowlby 1951). Despite later attempts to reduce his claims (Bowlby et al 1956), his earlier work on mother-infant separation remained influential in promoting the idea that intervention had to be early to be effective. Bowlby's work, like that of Freud, was retrospective in nature and for this reason it is impossible to tell whether attempts at restitution would have been effective, had they been tried. Freud had earlier advanced the notion that neurosis could only be acquired before the age of six (Freud 1938 trans. 1949). Thus over-dramatising the enduring effects of early trauma on the adult character structure.

The 1943 Goldfarb study was quoted extensively by Bowlby (1951) as support for the maternal deprivation theory. Goldfarb followed up fifteen pairs of children who had either been fostered at a few months old or by age three. His findings of personality disturbance in the later adopted group fitted in with those of Bowlby's. Goldfarb (1943) attributed the 23 point IQ difference on WISC between the two groups, when followed up between the ages of 10 to 14, to the 'critical' time of their placement. This study cannot be challenged on the grounds that it was retrospective, however, it is significant that one group was offered for immediate placement and the other was not. One needs to know what selective factors were operating in the 'placement policy'. Furthermore, no attempts at restitution were made for the late adoptees.

The Dennis study (1976) similarly errs: Dennis concluded that the *discrepancy* between the performances of children who were late adopted and institutionalised with those who were placed early was due to the latter groups' ability to overcome pre-adoption retardation, before they reached the 'critical' age of two. Once again it is likely that selective factors influenced the age at which children were considered suitable for placement. At least one part of the study is unequivocal: previously foundlings from this institution in the Lebanon had, if they were girls, gone to an equally poor establishment but if they were boys been moved to a better one when aged six. The prognosis for the girls was worse than for the boys but both groups evidenced a lower intelligence, a higher incidence of social maladjustment and personality disorders than their adopted counterparts. The outcome in all cases closely followed the direction and extent of the environmental shift.

Claims of the alleged importance of the early years may have been inflated by Bloom's erroneous use of "percent of development" (Clarke & Clarke 1984). Bloom's (1964) analysis of longitudinal correlation studies for physical characteristics, IQ, attainment and personality led him to conclude that fifty percent of a child's intelligence is already developed by the age of four. This implied that half the battle for the improvement of cognitive abilities had been lost if a child was not started on a programme of stimulation before this age. This complemented Hunt's (1961) earlier suggestion that a greater modifiability of development existed than was previously accepted, particularly in the early years. Clarke and Clarke (1984) point out, however, that human development does not necessarily occur in an orderly, continuous fashion and it cannot be measured on a linear scale of progress which yields percentages. Moreover, Bloom's study only concerned 'normal' children reared in their own homes and did not include studies of <u>changed</u> environments.

The effects of early trauma may be harmful and special ameliorative measures may be necessary to overcome them, but a good prognosis for recovery need not be confined to those of tender age. The arguments have been well rehearsed in A.M. and A.D.B. Clarke's book 'Early Experience: Myth and Evidence' (1976). They suggest that early learning is important for its foundational characteristics, which serve as links in the developmental chain, but without reinforcement the effects will fade with time.

> "If the view is to be accepted that early experiences exercise a disproportinate influence upon later development, the conclusion is inescapable that learning at this stage is particularly efficient and persistent. There is no evidence that this is the case, and a considerable amount of data which negates it."
>
> (Clarke & Clarke 1976, p.19)

RECOVERY FROM ENVIRONMENTALLY INDUCED RETARDATION

Studies where major environmental shifts have occurred (for example, when children are rescued from conditions of extreme adversity) have important practical and theoretical implications: they allow estimates of the 'limits' of change; they have a bearing on the theoretical prospects of upgrading the level of functioning of various deprived groups and they determine whether or not particular periods of development are 'formative' . If a child aged five plus is provided with a stimulating environment, after an upbringing of gross deprivation, yet makes no recovery, then this would be support for the formative-years hypothesis. More than fifty studies exist which report degrees of recovery in response to changing cirumstances and in the rare cases of negative findings, plausible reasons can be advanced to account for them (Clarke & Clarke 1984).

In the early 1930's and 40's important work began to emerge from the Iowa school which powerfully suggested that the quality of the earliest environment was reflected by later achievement and adjustment. One of these well-known studies concerned the fate of 25 children, who were all initially from the same poor orphanage, that were either adopted, aged approximately three and a half, or who remained in the mental retardation institution to which they had all been moved. After two years the latter group began to show progressive mental retardation: with an average loss of 26.2 IQ points as compared with an average gain of 28.5 points evidenced by the adoptees (reported by Skeels 1966).

Twenty years later both samples were traced for a follow-up study. With only one exception the divergent pathways of the two groups had been maintained. It was discovered that one boy was deaf so after eight years at the institution he was moved to a school for the deaf where his subsequent progress was good. Those who had been adopted enjoyed educational and occupational achievements in line with the natural-borns of their placement families; whilst those who remained in the institution were heavily dependent on State care (Skeels 1966).

The impact of Skeels follow-up study was considerable. His findings seriously challenged the prevailing 1940's doctrine which suggested that IQ was fixed and related to that of 'biological' parents. Coupled with two other publications - Bloom's (1964) 'Stability and Change in Human Characteristics' and Hunt's (1961) 'Intelligence and Experience' - it made it almost inevitable that early intervention would come to be viewed as a weapon for combating social injustices.

What researchers in the 1960's failed to appreciate, including Skeels, was that although Skeels undoubtedly demonstrated the role of the environment in cognitive development, he did not show that the recovery was specific to an early age. Skeels' findings have been challenged by Longstreth (1981) on the grounds of poor methodology, however, the methodology actually worked against him. In the initial matching of the adoption and institution samples the latter group started from a more favourable position in terms of IQ points. The study remains a classic in the annals of psychology.

The prognosis for the success of late-placements and adoption are not as poor as the studies by Goldfarb (1943) and Dennis (1976) had implied. Hilda Lewis (1954) and Alfred Kadushin (1970) have, for example, both conducted large-scale studies and found that the majority of children, who were placed after leading lives of emotional and physical neglect, could make satisfactory adjustments to their new lives. In the case of the 'Mersham study' (Lewis 1954) 438 out of the 500 children were older than five, whilst all of Kadushin's sample of 91 were between the ages of five and ten at the time of placement. These children were certainly not the 'affectionless psychopaths' that Bowlby would expect as a result of a delay in 'good mothering', beyond the critical age of two and a half (Bowlby 1951).

Further evidence of the resilience of at least some children in overcoming exceptionally severe early deprivation can be tragically but dramatically illustrated by individual case studies. A Czechoslovakian psychologist, Jarmila Koluchova, has fully documented the case of monozygotic twins who had undergone appalling cruelty, isolation and criminal neglect at the hands of their psychopathic stepmother. When they were discovered, at the age of seven, assessment showed their physical growth to be retarded; they displayed symptoms of emotional maladjustment and their IQ's were in the forties. Hereafter they were given an intensive rehabilitation programme and were later adopted by two sisters. In this positive atmosphere the children flourished. At age nine their IQ's were 82 and 73 on the WISC, and by fourteen they were 100 and 101 respectively. The social and emotional adjustments made by the twins had far outstripped expectations for them based on their condition at age seven, and they are still developing (Koluchova 1972, 1976).

It seems that early negative experience does not, by itself, necessarily affect later cognition. Total ecological change has proved dramatically successful in alleviating the symptoms of psychic damage inflicted on children whatever their age, although it may take sustained effort to do so. Early intervention must be considered desirable on the grounds that prevention is better than cure, however, late intervention can also considerably ameliorate, or even overcome, mild mental retardation.

COMPENSATORY EDUCATION PROGRAMMES

Examples of recovery from environmentally induced retardation have been cited to indicate the possibilities for change after intervention. Studies such as that by Skeels (1966) are, however, life long and complete. The question is: Can a relatively short-term educational programme promote lasting change? According to Jensen (1969) it cannot; "compensatory education has been tried and it apparently has failed." (p.1). He was, of course, referring to one of the most massive and controversial social experiements of our time: Project Head Start. The impact of Head Start on cognitive redevelopment programmes was twofold: firstly it focused research attention almost exclusively on the under-fives; and secondly, when the final blow came, it created widespread scepticism about the efficacy of educational intervention programmes, even if not confined to the under-fives.

Head Start was launched on the assumption that if the disadvantaged child was to be innoculated against the ravages of deprivation, he must be 'caught' at an unusually rapid period of development and before the 'critical period'. Children at risk for failure could thus develop learning readiness skills, prior to their initiation into the formal public school, and the doors to educational and occupational opportunity would be open for all. It reflected a nationwide concern for the problems associated with poverty. The details of this programme have been ably documented in Zigler and Valentine's book: 'Project Head Start: A Legacy of the War on Poverty' (1979).

Despite the warnings of some experts Head Start was launched as a full scale social programme. The speed of its inception resulted in a number of poorly designed and poorly evaluated studies. Disillusionment with the Head Start experience was quick to set in. Unfavourable reports appeared as early as 1967 when Wolf and Stein concluded that the initial advantage of Head Start children, in terms of classroom adjustment, disappeared after the first few months of kindergarten.

The Westinghouse Learning Corporation were called upon in 1969 to evaluate the effects of Head Start. Their findings, as quoted by Little and Smith (1971), are identical to those of Bronfenbrenner, who later analysed the results of twelve of the better home and school based early educational programmes (Bronfenbrenner 1976). Both reports suggest that dramatic changes in educational performance are not likely to accrue from broad-based, short-term, pre-school programmes. The initial gains of Head Start's participants, in terms of IQ, showed a progressive decline with time. These 'fading' effects have been reported too often to be ignored.

This should not have been a complete surprise to Congress.

Caruso, Taylor and Detterman (1982) have tabulated the results of early intervention programmes conducted both before and after 1965 and the pattern is the same: 43% of those before 1965 (13/30), and 49% after (24/49) failed to show <u>any</u> difference between 'treated' and 'non-treated' subjects. The authors conclude that Head Start is a 6.5 billion dollar reminder of the need to guide social policy through social science.

Not everyone agrees with the view that Head Start failed. A Consortium of 12 independent research teams, headed by Irving Lazar, have pooled the results of their early-intervention programmes and claim that there are lasting effects (Lazar et al, 1977, Darlington et al 1980). Consistently fewer participants require special education placements or need to repeat grades in school. Lazar and Darlington's reports have now been published in monograph form (1982). The findings of the Consortium have been used by Zigler and Berman (1983) in their claim that Head Start is a 'proven' success. Indeed, under the Reagan administration, Congress has awarded the project its first major increase since 1965.

The goals of promoting self-esteem and social skills of which 'Head Start' now boasts, although admirable, are not however the ones for which the project was launched. The majority of writers remain more sceptical about the potential of such programmes to secure lasting changes in cognitive performance. Even those in favour of Head Start, including Zigler and Berman (1983), admit that it was foolhardy to isolate the early years as a 'magical' time for guaranteeing intervention success.

Only the surface has been scratched off the mountain of literature that the compensatory education debate continues to generate. An excellent and up to the minute review is provided by Ann

Clarke (1984). It seems that where rigorous evaluation has been conducted the 'effects' are not maintained, however, they are much more dramatic where the intervention has come close to total ecological change.

Two intervention programmes for seriously disadvantaged infants, which commenced almost from the moment of birth, have revealed more lasting gains in terms of intelligence. Ramey's Abecedarian project produced a 12 point IQ differential between experimental and control subjects when aged four and an 8 point difference when aged five (Ramey & Campbell 1980). The Abecedarian findings have been interpreted by Ramey and Haskins (1981) as support for the early intervention movement. The results of the Milwaukee Project, where the mothers also received 'treatment', are even more impressive: the experimental subjects maintained an IQ differential of between 20 and 30 points over the control subjects until the age of school entry (Garber & Heber 1982). Four years after the project ceased the difference was still 18 IQ points (an effect size of approximately 1.5 standard deviations), however, both groups had by this time slipped behind national norms on measures of school achievement; a decline which Garber and Heber expect to continue.

Educational intervention has proved unable, in the past, to secure lasting gains for disadvantaged groups. The evidence is however only based on early (pre-school) programmes. As a result of the former erroneous belief in the prepotency of the effects of early experience, there has been little direct evidence of the modifiability of cognitive competence in adolescents and young adults. It may not be appropriate to assume that because early programmes do not seem to work then nothing will work. Working with young children may be fundamentally different to working with older children: where young children are concerned the programmes are generally preventative, whilst for older children they tend to be remedial.

The well-known Coleman report (1966) documented the relationship between the school environment and achievement. Coleman found that the quality of the school attended influenced low-socioeconomic-status children to a far greater extent than their middle-class counterparts, and that their attitudes towards school and self accounted for much of the difference. In a more recent review however Rutter (1983) argues that the quality of the school environment could exert an independent influence on pupil performance of as much as one standard deviation. Thus the school may play a more important role in development than Coleman supposed; the implication is that we need not be as pessimistic about the possibilities of formal schooling to overcome academic deficits engendered by impoverished family backgrounds. Furthermore, there is no reason why compensatory programmes should not also address the debilitating factors of low motivation, as Feuerstein's Instrumental Enrichment attempts to do.

Educational intervention has so far been dealt with as a unitary phenomenon but it is not. The various conceptualisations of impaired performance lead to quite different courses of action which may even be contradictory. Feuerstein's own intervention model will be introduced in Part 2 of this review, in contrast to the alternative forms of remedial intervention which shall now be outlined.

APPROACHES TO EDUCATIONAL INTERVENTION

As Feuerstein's IE programme is remedial in nature, training studies with average and above average children have not been included in this review. There are basically four theoretical viewpoints of the origins of learning difficulties: 'neurological/deficit', 'development lag', 'academic' and 'deficiency'. Feuerstein's approach is most closely allied with the latter. The intervention methods based on these models can be crudely placed along a person-environment continuum: at the biological extreme learning difficulties are perceived as residing within the child, whilst the behaviourists (academic model) understand the disability in terms of identifiable learning problems resulting from ineffective educational experience.

Without presenting a detailed historical overview of the four major traditions, each will be discussed. Since the developmental-lag model has least to offer in terms of remedial action it will be dealt with first.

DEVELOPMENTAL - LAG MODEL

Theorists postulate that the development of 'handicapped' children proceeds in the same sequence as for the non-handicapped but at a much slower rate. Some similarities exist between this model and the deficit one in that learning difficulties are seen as arising mainly within the child. Immaturity in some or all of the components of the central nervous system, delays in sensory integration, differential rates in brain maturation and lateralization and delayed development of selective attention mechanisms have all been advanced as reasons for poor school performance (see Hagen et al. 1982). The concept of immaturity has been taken to suggest both that the 'disabled' youngster may become fixated at a low stage of development (Inhelder & Piaget 1958), and that the child may eventually develop the area of relative weakness and achieve an adequate level of competence. The approach to intervention is extremely passive. Some developmental theorists believe learning difficulties often arise when children are required to achieve things before they are ready to do so. If children develop at different rates it may therefore be easier to wait until the readiness skills occur spontaneously (See Hagen et al. 1982). This wait-and-see philosophy does not result in positive educational training programmes.

There has been little work done on the neurological delay hypothesis and where it has been done the results are inconclusive. Research efforts have been focused on attempts to identify neurological predictive antecedents of learning disabilities or in establishing the incidence of neurological abnormalities in learning disabled children of different ages. They have not been concerned with accelerating development in order to overcome the delay. The predominant influence of the deficit model (below) in the 1960's meant this approach made little impact in the field of learning disabilities.

NEUROLOGICAL/DEFICIT MODEL

Much of the research in learning disabilities has attempted to link different types of learning problems to aberrations, dysfunctions or damage to the central nervous system, genetic constitutional factors or abnormalities and integrative deficits in the sensory modalities. In other words, learning difficulties are seen as overt manifestations of an underlying pathology. In spite of their differences, these theories endorse remedial procedures aimed at overcoming the underlying process deficits as a prerequisite to the enhancement of academic performance (the symptom). Workers in this field, notably Cruickshank (1967), first coined the 'minimal brain damage' label for children with learning difficulties.

The electroencephalogram (EEG) is widely used to diagnose minimal brain dysfunction, however, Freeman (1967) has reviewed the EEG literature and found that the technique has very low reliability;

there were no cases where neurological signs could be correlated with a specific learning disorder. Furthermore, some children with unmistakable cerebral abnormalities function well within the average range of academic achievement and intelligence (Lewin 1980). Freeman (1967) reports both that estimates of abnormal EEG recordings in 'normal' populations range between 10 and 20%, and that the spectrum of behaviour for children with abnormal EEG patterns ranges from complete normality to total incapacitation. The evidence for measured brain damage amongst children with learning difficulties is, to say the least, inconsistent.

Cruickshank (1967, 1983) views all learning difficulties as 'perceptual' deficits that arise from structural damage to the brain which may be too minor to be detected by present methods. Damage is presumed to cause impaired ability to focus on relevant stimuli whilst filtering out irrelevant ones.

Remedial programmes developed from 'medical' based theories have been translated into commercially marketed programmes. The most available are those which teach-to-the-deficit, which is typically conceived as perceptual or motoric in nature. Amongst others, these include the Frostig programme for the development of visual perception (Frostig & Horne 1964), and the development of perceptual-motor skills advocated by Kephart (1960). The training recommendations of the latter would include balance beam walking and so on, in order to develop a system of spatial awareness which is thought to be a pre-condition for symbolic thought to occur.

The psycholinguistic deficit model, as typified by the Illinois Test of Psycholinguistic Ability (ITPA), does not make the same assumptions about neurological correlates of behaviour. It does, however, share the premise with other 'deficit' approaches that the development of the skill, in this case psycholinguistic, precedes adequate cognitive development. ITPA was developed by Kirk and McCarthy (1961) as a means of matching remedial effort directly to the individual's specific psycholinguistic problems, as identified on the test.

Such programmes have been examined critically, and rejected, by the behaviourists. Treiber and Lahey (1983) claim that where minimal criteria for experimental design have been met it seems that perceptual and/or perceptual-motor training does not result in academic improvements when performances are compared with those of untreated controls. In a review of 38 studies which used ITPA as the primary source of data for remedial planning, ITPA failed to improve academic achievement (Hammill & Larsen 1974). Furthermore, it has not been conclusively shown that ITPA remediates psycholinguistic skills, (Newcomer et al. 1975).

Since Feuerstein's Instrumental Enrichment (1980) also offers a form of teaching-to-the-deficit it might be thought, by some, as similar to these earlier ability training models. The position taken in this thesis is that Feuerstein's programme more closely represents the views of metacognitive theorists. A discussion of the differences will be left until after the metacognitive (deficiency) approach and Feuerstein's model of intervention have been introduced.

ACADEMIC MODEL

The behaviourists introduced the academic model as a reaction to the failure of 'medical' based programmes to improve academic performance. They do not claim that process deficits do not exist but that a knowledge of etiological factors is of little importance in the actual process of intervention. Instead, the learning disabled child is thought to exhibit deficient academic behaviours which can be altered through techniques commonly used with other behaviour disorders (Lahey 1976, 1979).

Two major strategies have been used in the behavioural approach to the treatment of learning disabilities. The early studies dealt with behaviours believed to be incompatible with efficient learning such as impulsivity, attention deficits, and excessive motor activity. These accounts of poor learning have been looked at respectively by Williams and Lahey (1977), Marholin and Steinman (1977) and Ayllon, Layman and Kandel (1975). These authors concluded that treating these 'peripheral' deficits will improve the appropriate classes of behaviour (i.e. impulsivity, attention and hyperactivity) but unless academic behaviours have been targeted directly there will be no corollary improvements in these areas.

The findings of the Williams and Lahey (1977) study are pertinent to this investigation because the Feuerstein IE programme aims to correct the impulsive tendency, along with other cognitive functions considered to be incompatible with efficient learning, as a means of improving cognitive competence. Williams and Lahey investigated the hypothesis that in order to enhance the academic performance of impulsive pre-school children it was necessary to increase the latency of their responses. The results indicated that reinforcement for correct responses improved accuracy but not latency; secondly, reinforcing latency did not bring about increased acccuracy; and lastly, that it was no more effective to reinforce both latency and accuracy than it was to reinforce accuracy alone.

It is not really surprising however that if you give rewards to pre-school children their main concern will be to increase only those behaviours which will bring about immediate gain. Furthermore, there is little point in targeting peripheral attention or latency if the meaning or relevance is not clear to the child: he needs to know how and why it would be useful in the classroom. The ability to think reflectively is a developmental one which takes on a new perspective when the individual becomes aware of his own cognitions (Wiens 1983). Very young children, such as the subjects in the Williams and Lahey study, may be too developmentally immature to be expected to profit from this type of training; this does not mean that it is also inappropriate for adolescents.

The behaviourist approach to learning difficulties can rightfully boast successes in the short-term remediation of a number of 'academic' behaviours (including handwriting, reading skills, sight-word vocabulary, and arithmetic) with a variety of different populations (Lahey 1979). Yet, by their own admission (Treiber & Lahey 1983), there is a lack of studies showing the long-term effectiveness of such training.

It is the contention here that the behavioural approach can be useful when dealing with younger children or task dependent skills. The type of skills which behaviourists target are considered, by them, to be functionally independent. That is to say, reinforcement only improves the class of behaviour for which operant conditioning is available (Lahey et al 1977). The metacognitive approach, on the other hand, specifically aims to teach those processing skills that are applicable to many tasks (Brown 1978), but it may only be suitable for individuals who are old enough to be aware of their own thought processes.

THE METACOGNITIVE APPROACH

The metacognitive or 'deficiency' model is also conceptually distinct from former 'deficit' approaches to intervention: although both deal with processing difficulties, the metacognitivists offer a 'conceptual' rather than a 'concrete' based training. This type of approach is concerned with enhancing conscious awareness of the general strategies for thinking which can come under the executive control of the individual. Proponents of the 'deficit' model interpret learning difficulties as arising from central-processing deficits; poor intellectual skills are thought to be a consequence of inadequate sensorimotor experiences. This emphasis is therefore on the mechanics of sensorimotor integration.

The metacognitive approach has been derived from research in information processing (Atkinson & Shiffrin 1968) and cognitive developmental psychology (Flavell 1970, 1979). It will be argued that the learning disabled are developmentally immature in their spontaneous use of a number of strategic devices that aid information processing, and that they may be further handicapped by an extremely passive approach towards learning activities (Wiens 1983). The methodology for instruction is based on the assumption that self-awareness of thinking processes is a developmental ability which can be encouraged by training in metacognitive skills: that is, a knowledge of ones own cognition rather than the cognitions themselves.

The work of John Flavell, more than any other developmental psychologist, has been responsible for the current interest in research in the area of metacognition. In a definition of this term Flavell (1976) says:

> "'Metacognition" refers to ones knowledge concerning one's own cognitive processes and products or anything related to them, e.g. the learning relevant properties

> of information or data ... among other things, (metacognition refers to) ... the active monitoring and consequent regulation and orchestration of these processes in relation to the cognitive objects on which they bear, usually in the service of some concrete goal or objective.' (Flavell 1976, p. 232)

Metacognition can be refined into two aspects; what a person knows about his or her processes, conscious awareness, and the ability to control these processes. All the research on metacognition to be cited in this section is heavily dependent on Flavell's practical and theoretical contributions. Unfortunately, there is a paucity of studies concerned with the learning disabled child's ability to acquire metacognitive skills outside the traditional framework of memory research.

In a typical information-processing model (for example, Atkinson & Shiffrin 1968) a distinction is made between the architectural features of the system, its sensory registers and short and long term storage capacity, and the executive control processes that regulate the flow of information through the structural components. The function of the control processes are to direct attention to relevant stimuli and organise the material into meaningful units in order to facilitate memory. Whilst structural inadequacies and damage obviously have a bearing on processing expertise, evidence is also available to suggest that memory deficiencies are more often associated with deficiencies in executive processes than in the structural features (Brown 1974).

Developmental immaturity

Work done with learning disabled and young normal children seems to confirm that processing limitations are a consequence of developmentally immature control processes. The more complex the material the more apparent are the age related trends.

Developmentally young children are less able to justify their selection of strategies, they are more inconsistent in their use of them and they show less flexibility than older thinkers (Brown 1978, Butterfield & Belmont 1977).

Retardates, like younger children, are more immature in the use of information processing strategies. When matched on the basis of mental age, learning disabled youngsters perform in a manner consistent with younger children, and like younger children their abilities do improve with increasing mental age (Hagen & Huntsman 1971). Ann Brown also reports a similar developmental delay in her study of moderately retarded adolescents when the tasks involved <u>active</u> remembering strategies. When no deliberate memory strategy was involved however (for example in a recognition type task) no retardate deficiency was apparent (Brown 1974). This implies that the learning disabled are most handicapped when conscious 'executive control' decisions need to be made.

On the basis of fifteen years of research, Hagen and his co-workers have concluded that mnemonic strategy proficiency appears to move through four periods of change, (studies reviewed by Hagen et al 1982): initially the child does not produce a particular strategy spontaneously and training in this stage is rarely beneficial; during the period of 'mediational' inefficiency the skill may be easily trained although performance remains unaffected; later, a child may demonstrate 'production' deficiencies but this inadequate use of control processes can be remediated with the appropriate training; lastly, the child spontaneously and effectively uses a particular strategy. 'Mediational' deficiencies are analagous to the structural limitations of the system whilst 'production' deficiencies refer to inadequacies in the use of executive control (see Flavell 1970).

A passive approach to learning

Self-awareness of thinking processes is a developmental ability which takes on a new meaning when a child enters adolescence; it signals a heightened consciousness of their own and other peoples psychological processes. However, the learning disabled adolescent does not spontaneously use the strategies that normally develop independently and the problem compounds his or her inability to perform well in school. Poor work habits and poor motivation result in failure and failure can be self-perpetuating. According to Wiens (1983) the lack of structure and organisation in the thoughts of the learning disabled is largely a reflection of a lack of motivation and poor self concept. One solution to the problem of creating motivation and goal orientation is to demonstrate to these individuals the possibility of developing control over their own cognitive processes (Brown 1978, Wiens 1983).

There is a very real connection between motivation and strategic learning. Not only does failure breed resistance: it may also lead to a condition of 'learned-helplessness' whereby a student blames his lack of ability, rather than his lack of effort, for the failure. Dweck and Reppucci (1973) simulated this condition in the laboratory. Forty subjects were given both soluble and insoluble problems by different experimenters until an association was formed. Yet when the 'insoluble' experimenter switched to giving soluble problems some of the children continued to fail, although they could solve similar problems for his colleague. The learning disabled individual meets with failure and frustration in the classroom all the time.

Learning disabled children may be unable to adapt to the requirements of a task because they may lack the ability or the inclination to develop the use of appropriate strategies (Torgesen

1977). The failure is one of approach; conceiving themselves as incapable they have learned to become passive and expect things to happen to them. They do not expect to make things happen for themselves. The child's objective knowledge of his own cognitive processes is more than likely to be contaminated by his own feelings of competence or incompetence. Since he may have no reason to believe in himself as an active agent in knowing what there is to know in school, attempts to gaining such control may be minimal (Brown 1978).

<u>What kinds of skills should be taught?</u>

Learning disabled children may be better equipped to deal with classroom learning after being taught to actively control their own thought processes through a system of learning strategies. Ann Brown (1974) suggests that it might be profitable to direct training attempts at knowledge concerning strategies in general rather than in one domain-specific heuristic. If generalisation is the name of the game then it is necessary to teach skills which are useful in many different situations.

From a more extensive list of the types of skills necessary for efficient thinking, Brown has chosen four basic areas of training for the educable retarded adolescent: Recognizing, Planning, Monitoring and Checking (Brown 1978). She recommends that initially the teacher should play the role of the devil's advocate - always questioning the pupil's assumptions and premises - until eventually the student may come to perform these functions for himself through self-interrogation. A child can be taught simple guidelines: Stop and think! Do I know what I have to do? Is there anything else I need before I can start? Have I come across anything I already know that will help me? and so on (Brown 1978).

Meichenbaum's (1977) recommendations for self-instructional training are almost identical to Brown's, cited above, although they are only concerned with correcting one behavioural problem - impulsivity. He suggests that children who have difficulty with problem solving have not developed adequate 'mediational skills'. That is to say, they do not know how to use internal speech to guide their actions. Both Brown and Meichenbaum agree therefore that conscious awareness of internal thought processes will facilitate performance on cognitive tasks.

Can self-awareness of thought processes be trained?

Once again the majority of research has been conducted in the field of memory research and has been mainly confined to the laboratory. The general picture which emerges is that educable mentally retarded adolescents readily respond to training and evidence a variety of trained mnemonic skills which are also accompanied by satisfactory improvements in recall performance (Butterfield et al 1973, Brown et al.1974). According to these authors, the inferior performances of retardates on various memory tasks results from the lack of use of rehearsal strategies (remembering through repetition). They believe these processes can be trained since they come under the conscious control of the subject.

An encouraging study by Brown, Campione and Murphy (1974) indicates that, given appropriate and extended training, retardates may be able to maintain such strategies even in the absence of specific instructions to do so. The performances of ten moderately retarded adolescents (of average IQ 61 and aged approximately 16) who had received training in the use of rehearsal strategies six months previously, were compared with those of a similar group who had had no prior training. They were given serial-position recall (tracking) tasks which required them to keep track of examples presented sequentially, in an inspection set, for a number of variables: food, animals, clothes and vehicles. These variables had either two, four or six states (examples) and one example from each variable formed the inspection set. An efficient strategy is therefore to rehearse only the items in the inspection set, rather than trying to recall the states of each variable and then remembering which of these was shown.

The retardate rehearsal-deficit hypothesis was supported in that the subjects who had been trained to rehearse responded faster, more accurately and with more mature response patterns than those who had not. An interaction effect for the rehearsal X number of states was significant at the .05 level (a 0.62 standard deviation effect size in the difference between the means of the two groups). This suggests that the rehearsal group had maintained their strategy because they were not distracted by the irrelevant number of states of a particular variable. In addition, the serial position of the item did not influence the performance of the rehearsal group whilst for the non-rehearsal group the items that were presented early in the inspection set were significantly harder: the rehearsal X serial position interaction effect was significant at the .02 level (an effect size of 0.64 sd). Lastly, the three way interaction effect, rehearsal X states X serial position, was also significant at the .02 level (0.52 sd).

Brown et al.(1974) found the number of states of a variable had a considerable effect on the latency of response for the non-rehearsal subjects. This strongly suggests that the latter group were not employing the efficient strategy of remembering only the few items in the inspection set.

In sum, children with learning difficulties are viewed as sharing difficulties in common with younger children who find it hard to use the strategies which are basic to successful performance in school. As a result they are handicapped in acquiring and integrating new information and they are less proficient than average learners in using their general knowledge base. This 'production' deficiency may be remediated with additional support systems.

All learning is tied, to some extent, to the context in which it occurred and the less mature, the less experienced and less intelligent may suffer a greater degree of such 'binding' (Brown 1978). Nevertheless, each learning situation has varying degrees of generalisability and teaching a system of strategies for learning must have more than most. There is evidence to suggest that learning disabled and educable mentally retarded individuals can be taught to use these strategies to aid their cognition, (Brown et al 1974, Hagen et al 1982, Butterfield et al 1973, Egeland 1974). Despite clear implications for educational intervention however, this work has yet to be translated into comprehensive remedial programmes.

Support mentioned for Flavell's (1970, 1979) hypothesis of the developmental nature of these abilities indicates that this type of training may be more suitable for the <u>older</u> child who has not acquired these skills spontaneously. Feuerstein's Instrumental Enrichment (1980) offers such a metacognitive approach to the remediation of adolescents' deficient cognitive functioning. Feuerstein also provides a theory to explain the <u>etiology</u> of cognitive impairment which is directly linked to his model of intervention.

PART 2: FEUERSTEIN'S INSTRUMENTAL ENRICHMENT

MEDIATED LEARNING EXPERIENCE

> "...cognitive impairments emerge not necessarily nor directly because of poor genetic endowment or organic deficiencies. They result instead from the absence, paucity, or ineffectiveness of the adult-child interactions that produce in the individual an enhanced capacity to become modified, that is, to learn."
>
> (Feuerstein 1979, p.70)

The above quote serves as a formulation of the notion of insufficient mediated learning experience (MLE). This notion forms the theoretical foundation for Feuerstein's belief in the reversibility of deficient cognitive processes under specified conditions of intervention. The theory represents a considerable departure from conventional explanations of the etiology of low cognitive performance. The programme developed from the MLE construct is known as Instrumental Enrichment (Feuerstein 1980). It is a direct attack on those cognitive functions that are diagnostically determined to be responsible for poor intellectual performance.

The theory of MLE draws a distinction between two kinds of learning that supplement each other. The first may arise as a result of direct exposure to the stimuli (as a reaction to or interaction with the environment as understood by stimulus-response theorists and Piagetian psychologists respectively). In addition to this type of learning, Feuerstein explicitly postulates a second modality for the child's interaction with the environment; the human mediator (Feuerstein 1977, Feuerstein et al.1981A). Mediated as opposed to direct exposure learning does not depend upon chance confrontation with objects but on the impact of the adult's intervention in making the child focus or manipulate them.

The adult caregiver, initially the mother, deliberately interposes herself between the child and the stimulus in order to provide a framework through which the child may understand events. Her role therefore is to interpret events by investing them with meaning; she may bridge together those which are discrete in terms of spatial and temporal dimensions and activates the child's awareness by orientating him towards the encoding and decoding of reality. Mediated learning serves as a prerequisite to the effective and autonomous use of environmental stimuli by the child. Once the repertoire of examples of experience has been established, from which learning heuristics can be drawn, the child will be able to use them independently to make sense of his world.

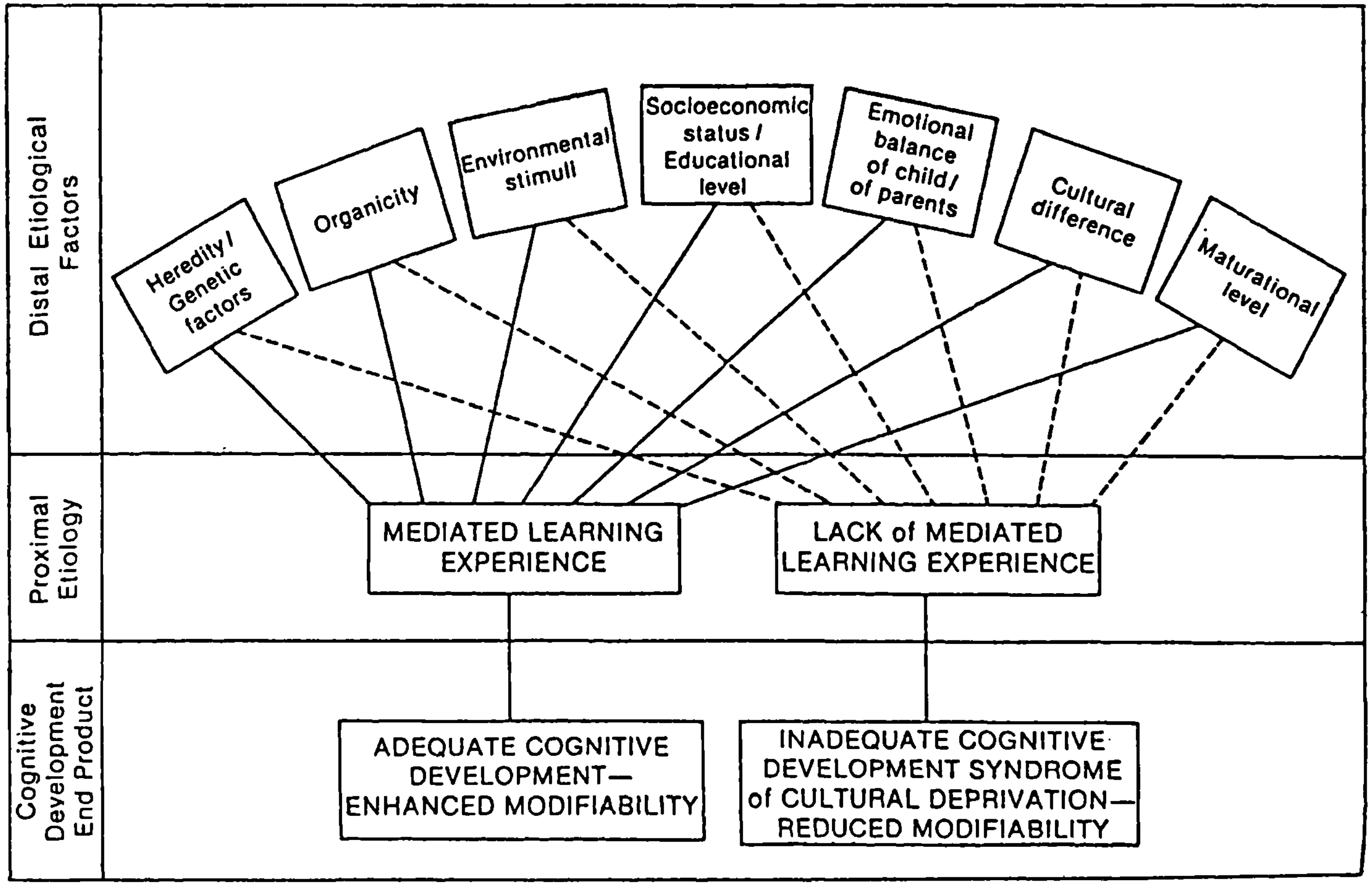
The mediational process may begin long before the child can talk. It is not the content of the mediation that is so important but more the <u>intentionality</u> on the part of the mediator: "...the learner is made increasingly aware that he is involved in a process of learning something that <u>transcends</u> the specific information and immediate needs around which the interaction takes place." (Feuerstein 1979, p.71 added emphasis). Parental interaction does not automatically qualify as mediated learning experience, to do so it must fulfil some of the following conditions: intentionality, transcendence, invested meaning, to inspire confidence or by regulating the child's behaviour in order to determine the pace and sequence of the learning (Feuerstein & Hoffman 1982).

Feuerstein is not alone in emphasising the importance of the adult's special role in facilitating the child's learning, as a mechanism through which culture becomes a part of each person's nature. Vygotsky's position adopted in the 1930's bears similarities although it was never translated into an educational package for cognitive redevelopment; using a historically laid down system of language the mother shows the child an object and names it - in doing so she changes the environment as perceived by the child. This serves as a most important evolutionary change in the child. Initially, under the guidance of the mother, the child uses speech to name the objects which interest him and this gives birth to a new category of internally organised activity. Once the speech has become interiorised it becomes the basis for the independent mental functioning of the child himself (Vygotsky, posthumously published 1962, 1978, see also Luria 1971).

Mediated learning experience is considered by Feuerstein to be the ingrédient which will determine differential cognitive development in otherwise similarly endowed individuals. If MLE is present then the child will develop his potential despite prevailing conditions of adversity (including: organicity, emotional disturbance of the child and/or parents, low parental education, cultural differences or correlates of social class). These environmental and constitutional factors may act singly or in combination to trigger the lack of MLE which is responsible for underfunctioning. In this theory (MLE) it is not assumed that these factors will in themselves lead directly or invariably to specific outcomes (Feuerstein 1977). See Figure 1 for a diagramatic representation of the distal and proximal etiologies of differential cognitive development.

There are no absolute numbers of MLE's which guarantee adequate cognitive development as this depends on the individual needs of the child; a brain damaged child or one that does not learn easily from direct exposure to stimuli may need more help in realising his potential than the average or gifted child.

If the mediation process breaks down, because the parents are unwilling or unable to provide it or the child unwilling or unable to accept it, then the appropriate learning sets, habits or motivation



<u>Figure 1</u>: <u>Distal and proximal etiologies of differential cognitive development.</u>
(Feuerstein 1980 p.18)

are not developed in the child. If the child is unable to make efficient use of his exposure to stimuli he may become the passive recipient of information, rather than being active in the cause of his own learning. This leads to a syndrome called cultural deprivation (Feuerstein 1980).

CULTURAL DEPRIVATION

The notion of cultural deprivation should not be taken to imply that certain cultures are in themselves depriving or deficient: Feuerstein (1980) uses the term to describe a situation whereby an individual is deprived of his own culture because of his lack of mediated learning. More specifically, he is deprived of the processes by which knowledge, values and beliefs are transmitted from one generation to the next. Even in a technologically unsophisticated society culture difference should not be confused with cultural deprivation, although the two can occur simultaneously.

Mediated learning is understood as the universal psychological component of cultural transmission. It occurs over and above the specific content of a task or a skill. For example, information must be organised, operations performed and an entire set of complex activities must be integrated into a purposeful and meaningful system of actions, whether the task be writing a computer programme or tracking an animal. "It (MLE) is the acquisition of structure that renders the individual adaptable or modifiable." (Feuerstein et al. 1981A, p.272).

Feuerstein does not assume that cultural deprivation, as a function of the lack of MLE, is an irreversible condition. On the contrary, the contention is that even as late as adolescence significant modifications in cognitive structure are possible. If the

MLE framework is accepted then it could be used to explain the instances of modifiability observed in the relatively late stages of cognitive development, i.e. after the 'critical' period; reflected in sharp changes in the courses of life otherwise dictated by heredity, organicity or early childhood deprivation (Feuerstein 1977). Examples of such cases would include those who demonstrate recovery from environmentally induced retardation (previously discussed).

Instrumental Enrichment (IE) was designed as a specific substitute for a lack of mediated learning experience. The teacher consciously assumes the mediating role that is taken intuitively by parents with the time and ability to assist their children. It is the opposite to the passive-acceptance approach towards retardation attributed to Jensen (1969): "since you cannot do what you want, better want what you can do". Instead, IE aims to alter the cognitive <u>structure</u> of an individual by addressing systematically a variety of poorly developed functions (see the cognitive map), which are symptomatic of a lack of mediation (Feuerstein et al. 1981A).

It would be hazardous and highly unethical to test out the exact nature of the relationship between MLE and cognitive performance. One could hardly manipulate MLE in order to determine the consequences of its presence or absence. Moreover, since MLE is not necessarily a conscious process it would be difficult to use it as an independent variable. There can be no direct validation of this theory. This must be done indirectly by monitoring the effects of a programme, (IE), designed to provide MLE.

Feuerstein claims that MLE effects structural changes which are lasting and, to some extent, self generating (Feuerstein et al. 1981A). That is to say these changes produce in the individual an ability to go on changing himself. Let us leave, for the moment, the empirical evaluation studies of IE to discuss the nature of this programme and the model of cognitive functioning upon which it was built.

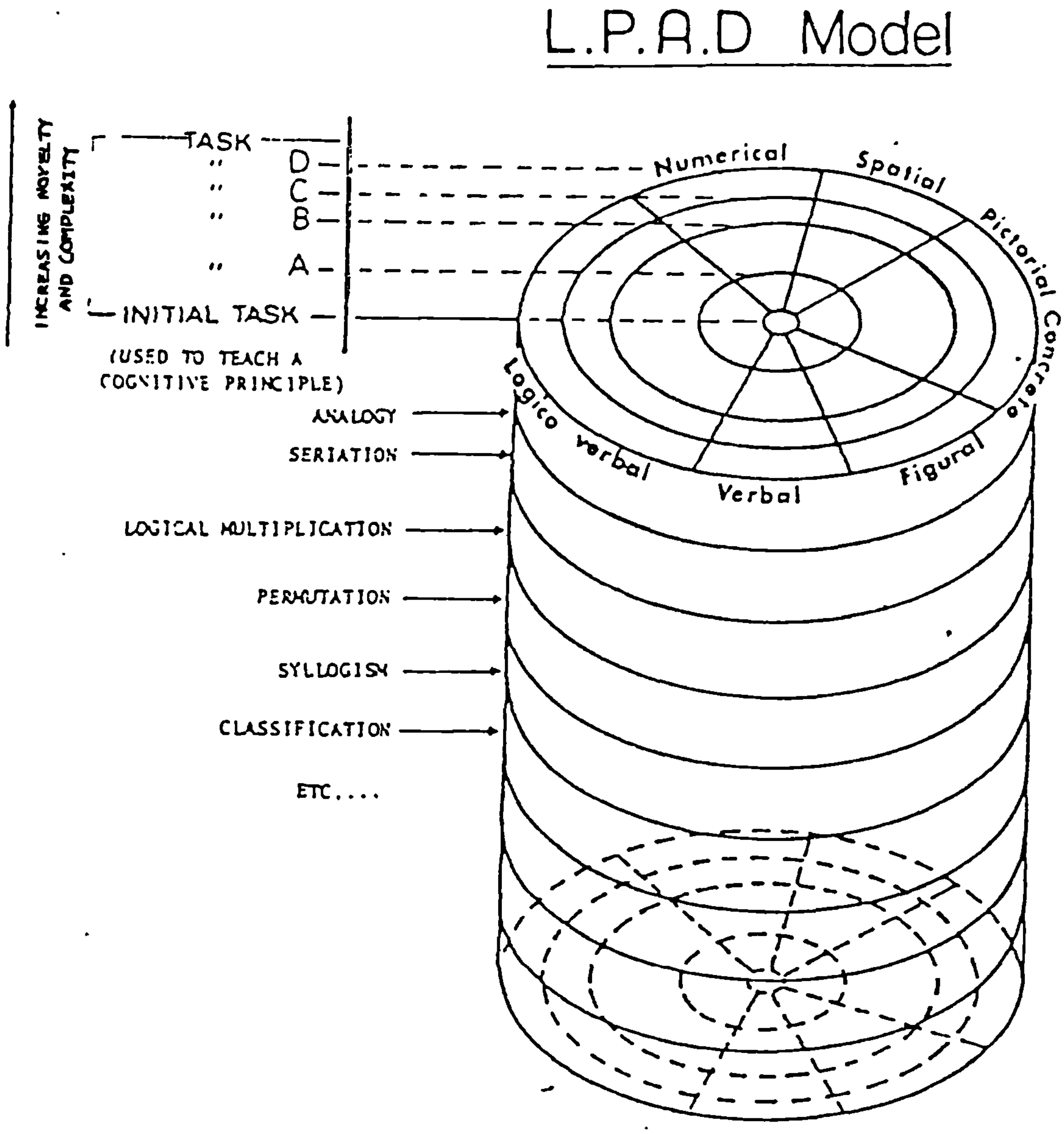
THE COGNITIVE MAP

Instrumental Enrichment is intended to correct and redevelop those functions that, because of their deficient nature, are responsible for retarded performance. These deficient functions are not necessarily considered elements that are totally missing from the cognitive repertoire, rather, they are considered as weak and vulnerable; their usage does not occur spontaneously, regularly or predictably in the culturally deprived child (Feuerstein 1980). These deficiencies do not occur in 'toto' or in the same combinations in different individuals. The cognitive map has been drawn up as a guide to the analysis of the components of impaired mental functioning.

Both IE and the parallel testing procedure; the Learning Potential Assessment Device (LPAD, to be discussed in Part 4), are developed from this model of the structure of the intelligence of the retarded performer. In LPAD the cognitive map serves as an aide-memoire in the investigation of the child's cognitive pattern of strengths and weaknesses; the results provide evidence of his potential or capacity for 'modifiability' (see Part 4). The IE programme is designed to consolidate the gains made during the test through the provision of prolonged exposure to mediated learning opportunities. In this case, the cognitive map is used in the construction of the material to ensure that, over the course of the programme, all aspects of low performance will have been visited.

The model consists of seven parameters (Content, Operations, Modality, Phase, and levels of Complexity, Abstraction and

Figure 2



(Feuerstein 1979 p.93)

Efficiency), which will first be described and then discussed. For testing purposes three of these parameters have been represented diagramatically (see Figure 2). However, the Phase parameter, which is most useful to assessment as it provides a list of possible impaired functions, is not built into the structure of the model. Let us start with the parameters that feature in Figure 2.

Modality

The modalities are listed round the top of the circle. The different modalities required by a task, or utilised by the subject, correspond roughly to the abilities as described in the psychometric tradition (e.g. Thurstone's test of Primary Mental Abilities, 1954). For example, verbal (spoken or written word), figural (geometric shapes), pictorial, numerical and so on. They may arise through the different sensory or motor systems. Individuals differ markedly as to which modality they find it easier to process in and a given individual may have pronounced preferences or strengths in one area relative to the others. Sometimes failure is erroneously attributed to the difficulty of the task instead of processing difficulties within a particular modality (Feuerstein 1980).

Operations

The operations are listed down the side of the cylinder (Figure 2) and are Piagetian in nature (see Inhelder & Piaget 1958, 1964). They may be understood as a set of internalised, organised and coordinated actions that a student must apply to the stimuli in order to produce a solution to the problem. The operations may range from simple recognition or identification of objects to more complex activities such as classification and seriation which involve a number of activities. These higher-order operations may be dependent on the development of a number of prerequisite cognitive functions. In cognitive redevelopment programmes it is necessary to be aware of the operational demands made by certain tasks to ensure that the preceding instruction covers the component elements and skills.

Complexity

The level of complexity refers to the quantity and quality of the units of information involved in the production of a given mental act. The quantity aspect relates to the absolute number of units involved whilst the quality denotes the degree of novelty of the material. The more familiar the units are the less complex the task, even if the units are multiple, and conversely the less familiar the more difficult.

In terms of the LPAD model the complexity of the tasks are represented by the diverging concentric circles. The centre of the diagram indicates the task that is presented to the examinee for solution whilst the outer rings show tasks of increasing complexity. Difficulty is again conceived in terms of novelty and this is achieved by changing one of the parameters inherent in the task. The novelty refers to the number and nature of dimensions introduced into the task as compared with the initial task (Feuerstein 1979).

Phase

Perhaps the most critical aspect of the model, for both the teacher and tester, is the Phase parameter. It is this parameter which contains the check list of cognitive functions which may be poorly developed in individuals that have had insufficient MLE (see Table 1). These functions are prerequisite to the efficient use of

Table 1

The Nature and Locus of Cognitive Impairments

The Input Phase

1. Blurred and sweeping perception
2. Unplanned, impulsive and unsystematic exploratory behaviour
3. Lack of or impaired receptive verbal tools that affect discrimination
4. Lack of or impaired spatial orientation
5. Lack of or impaired temporal concepts
6. Lack of or impaired conservation of constancies
7. Lack of or deficient need for precision and accuracy in data gathering
8. Lack of capacity for considering two or more sources of information at once.

The Elaboration Phase

1. Inadequacy in the perception of the existence and definition of an actual problem
2. Inability to select relevant vs. nonrelevant cues in defining a problem
3. Lack of spontaneous comparative behaviour or limitation of its application by a restricted need system
4. Narrowness of the mental field
5. Episodic grasp of reality
6. Lack of or impaired need for persuing logical evidence
7. Lack of or impaired interiorization
8. Lack of or impaired inferential thinking
9. Lack of or impaired strategies for hypothesis testing
10. Lack of or impaired planning behaviour
11. Non-elaboration of certain cognitive categories because the verbal concepts are not part of the individual's repertoire on a receptive level or are not mobilized at the expressive level

The Output Phase

1. Egocentric communication modalities
2. Difficulties in projecting virtual relationships
3. Blocking
4. Trial and error responses
5. Lack of or impaired receptive verbal tools for communicating adequately elaborated responses
6. Lack of or impaired need for precision and accuracy in communicating responses
7. Deficiencies in visual transport
8. Impulsive acting out behaviour

From The Dynamic Assessment of Retarded Performers. (Feuerstein 1979). Summary of pp.58-60.

complex operations. The deficient functions are broadly grouped into three stages (phases) of mental processing: Input (or data gathering); Elaboration (where the processing of stimuli occurs); and Output (the communication response). Errors can occur in any or all of these phases. The phases are linked with a fourth dimension; affective motivational factors affecting cognitive processing.

Although the phases have been isolated for descriptive purposes, Feuerstein (1980) specifically states that it is not intended to endorse a simple linear cognitive processing model. The interactions between the phases are complex. Inevitably underfunctioning in one area affects processing in another; if you have failed to gather all the relevant information about a problem (input phase), then any mental transformations are completed on insufficient or imprecise data. The deficiences in the input and output stages are viewed as most accessible to change through intervention; should the elaborational capacity exist in an individual, he may be able to bypass reception and communication problems to reveal a greater level of functioning than could be anticipated on the basis of the peripheral deficiencies. Helen Keller is cited as a case in point (Feuerstein 1980).

When one is aware of the locus and nature of an incorrect response then remediational effort can be directed at source. The IE materials are designed to provide extensive opportunities for the child to practise and internalise these skills. A complete description of the deficiencies, as conceived by Feuerstein (1980), can be found in Appendix 1A.

Content

Each mental act can be described according to the subject matter (or content) in which it deals, for example; history, geography, mathematics etc., or a combination of these fields. Different individuals may be differentially acquainted with various subject matters. Very difficult or unusual content may simply overwhelm the pupil and divert his energy from learning the particular operation in order to deal with the subject matter. However, material which is too familiar may decrease interest or alertness to detail. These considerations should influence the selection of content when constructing teaching materials.

Level of Abstraction

This parameter assesses the distance along a continuum from a specific concrete object to an abstract symbol representing a universe of objects. At one extreme the content may involve materials that can be perceived through the senses or handled by motor manipulation. At the other, operations may be performed on representations of objects or even without reference to real or imagined objects and events.

Level of Efficiency

This refers to the speed or accuracy of a response or the amount of effort required by the student to produce it. The more recently a cognitive operation has been acquired the higher is the degree of inefficiency which is likely to be evidenced when the individual performs it. In addition, the degree of motivation and energy needed to produce a mental act is much higher for the culturally deprived student than his advantaged peer (Feuerstein 1980). Thus, even if the motivation levels are the same, the disadvantaged child may still be more inefficient in producing a mental act because of the greater amount of energy he needs in doing so. However, the efficiency level is modifiable; it will be improved as a result of repetition and acquisition of good work habits and strategies.

ANALYSIS OF THE COGNITIVE MAP

For curriculum developers the cognitive map is a blessing; it provides an eclectic source of hypotheses on how best to remediate the cognitive functioning of retarded individuals. For clinical and educational psychologists it may be viewed as an overdetermined, loosely defined model on which to base an assessment. The opinion very much depends on what is being asked of the model. The imprecision and ambiguity surrounding the parameters of the map is vitally important to the examiner who is trying to characterise a student's performance in the precise terms of the model; it is less so for the teacher who by training certain cognitive skills and functions unwittingly reinforces others which were not the direct focus of the lesson (this could even be advantageous).

The model would benefit from clarification. How do the parameters of the map relate to each other? For instance, in the LPAD model (Figure 2), do all the operations apply equally to all modalities; are there items where syllogisms operate on pictures and so on? It may not be important to gather information about an individual's performance at each intersection of the parameters on the LPAD model, but are there key areas? If so, which are they and how are they represented in the testing and training items? The parameters of the map may be complexly related, for example, certain operations could map directly to one or other of the phases of processing; would classification be an input operation? Are there explicit hierarchies of operations or the cognitive functions which are prerequisite to their successful performance? These factors may be implicit within the IE package but they need to be stated for the tester. The problem is further exacerbated by the new additions to the model as it continues to evolve. It is difficult to ensure the entire cognitive spectrum has been covered during the LPAD test if you are not certain at the outset the extent of the model on which to base the assessment.

Some of the specific problems related to LPAD testing shall be discussed in Part 4 but those related to the use of the model will be mentioned here.

The modality of presentation of the tasks (for both IE and LPAD) are to some extent constrained by the content of the material. The actual metacognitive training in IE is nearly always verbal (and logico-verbal) but the task content is often figural, numerical or spatial and so on. In practice, it is therefore difficult to make a distinction between an individual's processing ability in the spatial modality and his competence on spatial tasks. Feuerstein does not intend content and modality to be used interchangeably although they sometimes are: the research methodology employed by Feuerstein (1979, Chapter 7) to compare the effects of training in the verbal and figural modalities, for the latter actually describes verbal training in the figural modality (that is with figural tasks).

The inclusion of operations as a significant parameter of the cognitive map reveals the influence of Piagetian psychology. However, Feuerstein's 'operations' cannot always be recognised in this traditional sense. He enjoys a very liberal interpretation of what counts as one; examples from Organization of Dots (Feuerstein 1980, p.138) include - organization of the field with articulation and segregation; anticipation and representation; and for

Representational Stencil Design (p.245) e.g.'s include - segregation; differentiation; representation; encoding and decoding; and generalisation. Both of these instruments are also represented in the LPAD battery but it is difficult to see how one would monitor the emergence of these 'operations' or the efficiency with which they are performed.

In LPAD testing it is supposedly possible to measure the amount of learning by measuring the transfer to items of greater complexity (represented by the diverging circles on the LPAD model). However, there has been no analysis of the number of bits of information for the task demands of any tests in the LPAD battery. This is not surprising when the measure is confounded by an estimate of novelty or familiarity with the material. The tasks have not been standardised for difficulty and without this it is not possible to make relative judgments about an individual's performance across the modalities etc. The parameters of the map need to be much more formally defined if bits of information are ever to be counted.

Despite being the most interesting parameter, Phase causes the most problems for the LPAD tester. If the reader has digested the description of the deficiencies (Appendix 1A), then he will be aware of a great amount of overlap and redundancy. When testing, it is only possible to record examples of those deficient behaviours that can actually be observed. Furthermore, it is not helpful to find that episodic grasp of reality and narrowness of mental field share part of the same description; a passive approach towards learning where events are seen as unrelated to either the past or the future (which limits the impact of a learning experience). Others may look different on paper, and could probably be taught separately, but cannot be distinguished from the pupil's manifest response; on a matrix problem how would impulsivity look different from a lack of planning or a lack of comparative behaviour?

On the other hand, an observed behaviour in the testing situation may mean more than one thing: for instance, if a child indulges in trial and error behaviour, is this the result of his inability to process the material or the cause of it? (because he has invested too little effort in the solution).

It is possible that the cognitive functions are hierarchically related with low-level skills combining as prerequisite for higher-order ones. If so, it would be of considerable help to the examiner if specific LPAD items were graded for their component skills and level of difficulty. It is important to have the additional information on task complexity because an error (deficiency) that occurs on low-level tasks may be far more significant in terms of remediational effort than one that occurs when the task demands are high.

Lastly, the Abstraction and Efficiency parameters make little independent contribution to the model. To some extent the Complexity parameter encompasses the level of abstraction, whilst the level of efficiency can be influenced by any or all of the other parameters. The Complexity parameter could be given an operational definition; there has been one attempt to use Pascual-Leone's task analytic approach to estimate the task demands of the Representational Stencil Design Test in the Feuerstein battery (Bachor 1976), but this has not been acted upon by the Feuerstein team. Unfortunately Bachor (1976) did not investigate the effects of providing different amounts of adult assistance in the production of the child's solution, which meant that LPAD could not be used in the dynamic way for which it is intended. Furthermore, human factors such as 'degrees of effort' do not lend themselves towards quantification and it is difficult to see how they could be incorporated into the teaching programme.

The parameters of the cognitive map make good guidelines for the development of curriculum for retarded individuals. Many of the points which Feuerstein raises (1980) are valid: it is important to provide learning opportunities in many different areas (modalities in his language); the content must neither over or underwhelm the student or detract from the point of the lesson; and the basic cognitive functions and operations which are prerequisite to direct exposure learning must be systematically addressed. These factors have been incorporated into the IE package in a very interesting and explicit way.

The problems that overinclusion and loose definitions cause pose a more serious threat to the psychological validity of the model in assessment terms. Some of these difficulties could be ironed out through empirical work, especially in the area of the Complexity parameter, but others await theoretical elucidation.

INSTRUMENTAL ENRICHMENT

The metacognitive approach to the learning disabled adolescent is developed from the premise that he may become a more active learner by being taught a system of strategies for learning. Feuerstein (1980) has taken the metacognitive approach out of the laboratory and into the classroom. The Instrumental Enrichment programme is designed to foster in the low-functioning adolescent the specific learning sets, attitudes and motivations which are basic to learning. A progressive approach towards education is not suitable for the child who is unable to profit from direct contact with academic materials: for him the ground rules must be made explicit, he must be taught how to think about thinking and how to learn about learning. Only then will he be liberated into an autonomous thinker (Feuerstein & Hoffman 1982).

The reader will appreciate how unusual it is to have a remedial programme whose target population have already reached adolescence. Feuerstein (1980) is of the opinion that whilst the provision of MLE might have a greater impact on the young child, it is never too late to try and effect cognitive growth. The IE materials are designed in accordance with the parameters of the cognitive map and the theory of mediated learning experience. They are specifically intended for a population that is capable of an awareness of their own thought processes.

IE comprises a series of paper and pencil exercises divided into 15 instruments; each instrument focuses on a particular set of deficient cognitive functions but address also the acquisition of many other prerequisites of learning (Feuerstein 1980). IE acts as a <u>supplement</u> to the existing curriculum, it does not replace it. Each of the instruments are detailed in terms of their objectives, structure and the means by which they attempt to reach their specific goals, by Feuerstein (1980). These instruments include:

Organization of Dots
Orientation in Space 1, 11, & 111
Comparisons
Categorization
Analytic Perception
Family Relations
Temporal Relations
Numerical Progressions
Instructions
Illustrations
Representational Stencil Design
Transitive Relations
Syllogisms

The first two of these will be discussed in due course and examples from six of the other instruments can be found in Appendix 1B.

One very interesting departure from conventional remedial programmes occurs in the way IE materials avoid the use of regular curriculum subject matters. This is done for two excellent reasons: firstly, it provides the pupil with a learning situation which is free from association with previous school failure (with the bonus that the material is novel and interesting); and secondly, the learner is not burdened with a lot of subject information which might distract his attention away from the particular operation to be learnt.

There are continuous themes throughout all the instruments, so the learner may meet the same schemata on a number of different occasions with a variety of different contents, modalities and levels of complexity. This continuity serves two essential functions for the slow learner: it provides ample opportunities for repetition and practise of the skill and allows him to build up a repertoire of operations which can subsequently be applied to more complex material. The learner could not hope to remember all the solutions to the problems within an instrument, instead, he must learn the principles underlying their solution and transfer these across the successive units. There is a strong pressure for achievement in IE, not in the mastery of individual tasks per se but in the concepts and skills that transcend the task in hand.

Clarke and Clarke (1967) have investigated the learning transfer phenomenon with adult and child imbeciles and normal children. Two of their findings are particularly relevant to the above paragraph. Firstly over-learning (repetition) greatly facilitates transfer to other conceptual problems. Secondly, task complexity is a major determinant of transfer regardless of age; the greater the difficulty of the task, the greater is the transfer from one task to another. We are doing the imbecile no favours by making few cognitive demands on him, since the ingestion of simple material does not lead to generalised transfer. Thus we may inadvertently, and with the best of intentions, confirm the imbecile in his extremely low level of functioning.

The above authors suggest two factors which may account for transfer across tasks which vary in their nature: (1) through increased attention to details of the new task; and (2) experience in the act of making common responses to dissimilar stimuli. The fact that these subjects went on to demonstrate superior performances on parallel versions of the task suggests the formation of symbolic analogues, on the basis of acquired and overlearned associations (Clarke & Clarke 1967). There are greater possibilities for transfer if the skill has become ingrained and is of a complex nature. As will shortly be evident, the IE materials cannot be described as under stimulating.

The teacher plays a significant role in ensuring that the learning goes beyond the particular content of an IE lesson. This is achieved by 'bridging'; examples where the learning is relevant to other tasks or every day life situations are openly discussed in the class. Thus if the task the class have been working on involves precision and accuracy, the teacher steers the conversation around to the importance of these cognitive functions; the skills are important when making lists, following a recipe, packing for a holiday and so on. Both teacher and pupil are active in providing these illustrations.

In IE the teacher deliberately mediates to the pupils the meaning of a successful or unsuccessful performance. They discuss the cognitive functions which were important to the success and the best strategies for task solution. The teacher may also relate the events to spatial and temporal dimensions (for example, not here but there, not now but later) in order to create anticipatory frameworks within the child. Above all, the child is left with the feeling that he can succeed independently (Feuerstein & Hoffman 1982).

Formally stated the IE programme embodies six specific subgoals through which the cognitive modifiability of the adolescent can be brought about (Feuerstein 1980, Chapter 6). These are summarised as follows:

1. The correction of the deficient cognitive functions.

2. The acquisition of basic concepts, labels vocabulary, <u>operations</u> and relationships necessary for the IE tasks.

3. The development of an <u>intrinsic</u> need for adequate cognitive functioning and the spontaneous use of operational thinking by the production of crystallized schema and habit formation.

4. The production of insight and understanding of one's own thought processes, in particular those processes that produce success and are responsible for failure.

5. The production of task intrinsic motivation (performance for performance sake).

6. A change in orientation towards oneself from passive recipient, to an active generator of information.

The first two subgoals are testable (and shall be looked at in this investigation), the remaining ones, although noble, are rather ambitious. Certainly, there have been no empirical evaluations of IE which use these subgoals as the criteria for success. The case for IE seems rather overstated. The primary goal of any redevelopment programme must be to increase the level of successful performance of the pupils, however this is done, and the programme must stand or fall on its ability to do so. Subgoals such as number five are rather meaningless if the pupil performs for the pleasure of performing but without increased success. A summary of the characteristics of the IE programme can be found in Appendix 1C (taken from Feuerstein 1980).

However the reader may gain a keener understanding of IE through a brief look at two of the instruments.

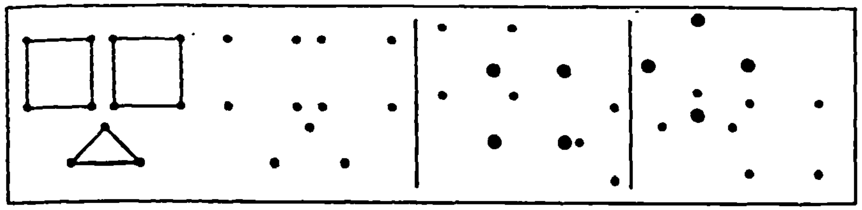
ORGANIZATION OF DOTS

Organization of Dots is the first instrument in the programme. The entire instrument is non-verbal in that the task throughout is to organise amorphous clouds of dots into geometric shapes according to a given model. Although the tasks do vary in their mode of presentation and the level of difficulty, the student must bear in mind, when looking for the shapes amongst the dots, that the orientation may be different to that given in the model and that the shapes may overlap one another. A glance at some examples of the material (see Figure 3) may make this clearer.

The first pages of the instrument involve projecting regular shapes (squares and triangles) on to the dots. Each dot may only be used once and the shapes must conform to the given model. Successful completion of the tasks involves several of the cognitive functions (listed in Table 1 and detailed in Appendix 1A). The student must project the relationships amongst the discrete entities, the dots, on a given task: to do this he must perceive the elements which constitute the figures (length and number of sides, angles and so on) and be able to conserve them across different orientations than the one given in the model. He must be able to hold the image of the shape in his mind's-eye whilst testing the goodness-of-fit of his proposed solution (visual transport). This demands considerable stability of the perceptual processes.

In addition to this the pupil must orient himself appropriately to the task; he needs to be precise in the way he identifies the relevant dimensions of the shapes and he must exercise considerable

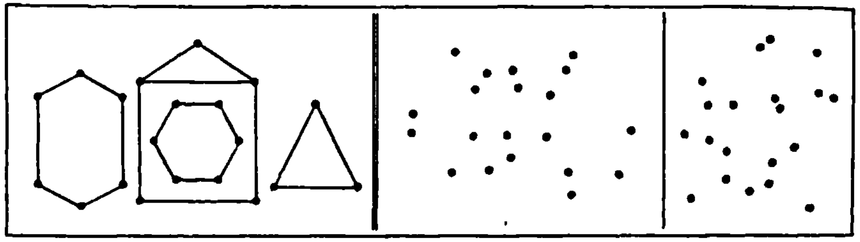
(1)



Organization of Dots (exercises 1, 2, and 3, page 3)

Constancy of the form of the square is conserved despite changes in its orientation.

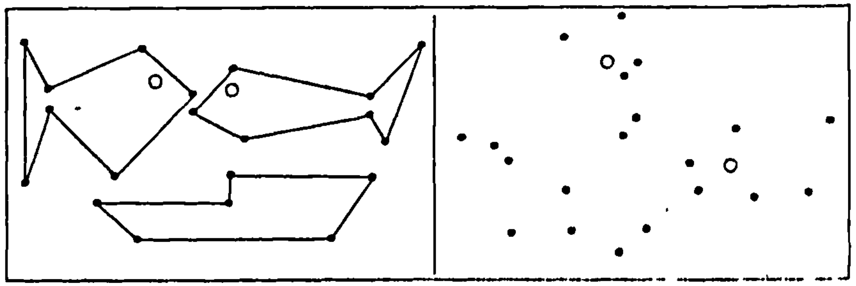
(2)



Organization of Dots (exercises 8 and 9, page 14)

Successful completion of the task requires complete input data which are contingent upon sufficient investment. The figures and their parts must be precisely and completely defined. To discriminate properly between the two six-sided figures requires a perception not only of the number of sides, but of their relative length. The orientation of the hexagon within the square serves as a cue in the search for the small triangle on top of the square.

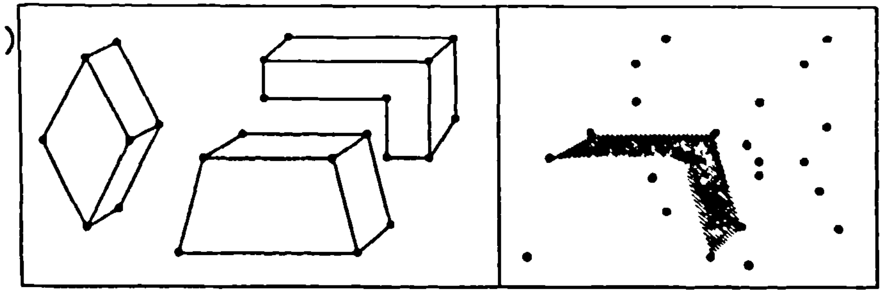
(3)



Organization of Dots (exercise 3, page 16)

Inasmuch as the eye, given as a cue, does not assist in discriminating between the two fish, a new strategy must be determined. There are two dots, close together, in front of each tail that can serve as a point of reference for locating the tail. By inference, it is possible to conclude to which fish the particular tail belongs. Then, by use of the tail and the eye, one may logically arrive at the orientation of the fish one has found.

(4)



Organization of Dots (exercise 6, page 20)

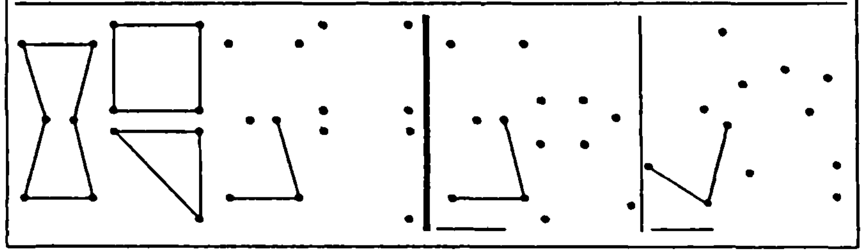
The complexity of the three-dimensional figures and the proximity between the dots create the need for segregation and differentiation.

(5)

Describe the kind of error you find in each frame according to the following key:

I = Incorrect Form
M = Missing Dot
S = Smaller Figure
E = Extra Dot

Draw an arrow to indicate the place of the error.



Find the Error—Organization of Dots (exercises 1 and 2, pages 5)

The student learns strategies for the critical examination of his own work through the identification of errors and their source.

Figure 3: Examples taken from Organization of Dots
(Feuerstein 1980).

restraint towards acting impulsively. The culturally deprived child may blur the essential features of the task and is easily misled by seductive distractors. Errors are often made when the dots are close together; the pupil may join his line to a dot which is nearly correct but results in an irregular shape, or, he may find a perfect shape but forget to take the size variable into account. The tasks are particularly hard in view of the fact that the three dots for the triangle cannot be distinguished from any three dots of the square (except that in each case there is only one solution and the pupil must test his hypotheses in his head until he has found one that uses all the dots appropriately).

As the instrument progresses the cues are gradually removed. In the first example the pupil was aided by reinforced dots to guide his search for the square, but in examples two and three these are no longer available. In the latter case the shapes are no longer symmetrical. The student must identify the features of the shape which will facilitate his search and employ them in his search strategy. This becomes even more important when three dimensional figures are introduced (example 4). Trial and error attempts are unlikely to result in the correct solution.

The IE pages are interspersed with pages of errors. In these instances the pupil has to find the inbuilt errors and in order to be successful one must have internalised all the skills mentioned above. The learner is provoked into adopting a conscious, critical approach to the tasks which eventually may transfer to his appraisal of his own mistakes. For the time being it is more motivating to work on somebody else's. An illustration of these error pages can be seen in example 5 which occurs early on in the instrument.

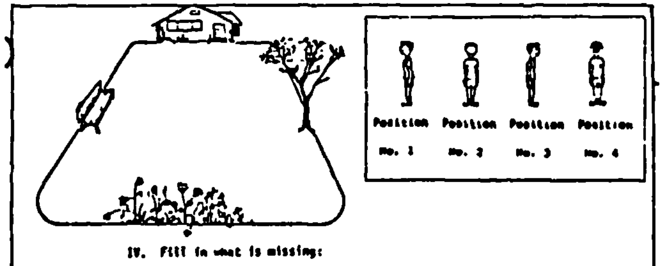
Organization of Dots has been analysed by Feuerstein (1980, p.138) in terms of the cognitive map:

Content:	Dots to be organized into geometric figures
Modality:	Figural
Phase:	Elaboration and output with projection of virtual relationships; all three phases (input, elaboration, and output) with the utilization of almost all of the functions.
Operations:	Organization of the field with articulation and segregation; differentiation and discrimination; categorization; anticipation and representation; inference; induction and generalization.
Level of abstraction:	Low in actual solution of the problem; very high when principles and rules are generalized and applied.
Level of complexity	Low when model consists of familiar geometric figures and a relatively small number of dots; very high with the introduction of unfamiliar, asymmetrical figures, an increased number of dots very close together, and the necessity for fine discrimination and choice between dots that proximate those sought.
Level of efficiency	Shows effect of practice; decrease in number of errors and increase in speed of solution, with restraint of impulsivity and use of adequate strategies for search; reduced investment necessary for solving problems of increased complexity and difficulty, in terms of both time and subjective expression of affect.

The parameters of the cognitive map have already been discussed.

The illustrations chosen show examples from only five of the 26 pages of Organization of Dots. The remaining 21 contain variations on these themes. Many of the skills have obvious bridging applications; particularly the need to plan ahead, to avoid impulsive decisions, and the need to be precise in both academic and everyday situations. More generally, the instrument implies a need to impose order on the world. Two instruments are taught simultaneously to avoid boredom. This instrument is often supplemented with Orientation in Space 1, which has a greater verbal content and may therefore need teacher assistance in reading the directions.

(1)



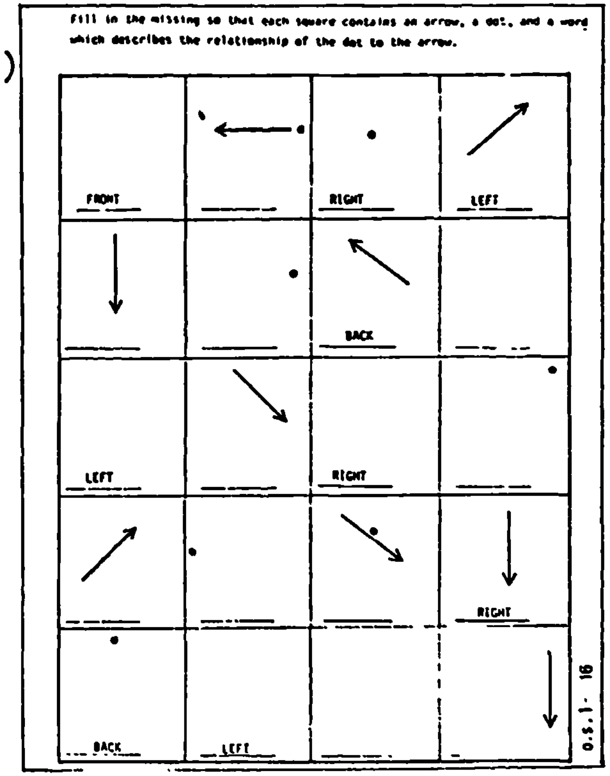
IV. Fill in what is missing:

Position	Object	Direction in Relation to the Boy
1	The tree	
4		right
2		back
	The house	front
3	The bench	
2	The house	
	The tree	left
4		back
	The bench	
		left
3		back
4	The tree	
		right

OSI 9

Orientation in Space I (page 9)

(2)



Orientation in Space I (page 16)

Orientation in Space I. To enhance the ability to use concepts and stable systems of reference for orientation in space — concrete, abstract, and interpersonal. Distinction is made between relationships that are relative and can be described from a multiplicity of angles and those that are stable and can be fixed by coordinates. Precise and accurate communication of information lessens egocentricity. *Left:* This page summarizes preceding exercises and illustrates varied repetition of a principle to facilitate habit formation. Solution requires: definition of the problem; visual transport or internalization; simultaneous use of several sources of information; systematic work; and hypothetical and inferential thought as a basis for logical conclusions. The student learns of delimitation of alternatives and how to summarize his data, using a table. *Right:* Solution involves: redefinition of the problem with each frame; the use of symbols, encoding and decoding; the conservation of the constancy of the relationship across variations in the orientation of the arrow; projection of virtual relationships; hypothetical thought; and precision in gathering and communicating information.

Figure 4: Examples taken from Orientation in Space. (Feuerstein 1980)

ORIENTATION IN SPACE 1

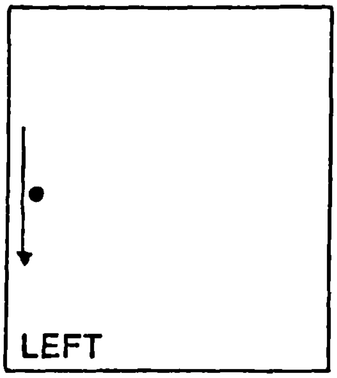
Orientation in Space is composed of three instruments aimed at producing a direct attack on one of the most commonly observed deficiencies in the retarded performer: his limited use of articulated, differentiated and representational spatial dimensions (Feuerstein 1980). For instance, he may only be aware of the position of things in relation to his own body but be unable to locate them in terms of anybody else's. (When standing opposite one another my 'left' is in the same direction as your 'right'.)

The first of the instruments (16 pages) deals with spatial orientation relative to one's own body; it involves the concepts of right and left and front and back which are initially established by using the body as a frame of reference. In the course of this instrument these relationships become more and more devoid of these concrete references (see the example in Figure 4.) The tasks in the first part of the instrument deal with the relationships between fixed objects (a house, tree, flower and bench), and the human figure (standing in one of four positions). The relationship of the objects to the human are contingent upon the latter's orientation. The second half of the instrument introduces arrows and dots with the dots in place of the objects and the arrow heads symbolically representing the face of the human, (see example 2, Figure 4). Other intervention programmes for the retarded rarely demand that the performer detaches himself from a concrete, motoric modality of performance.

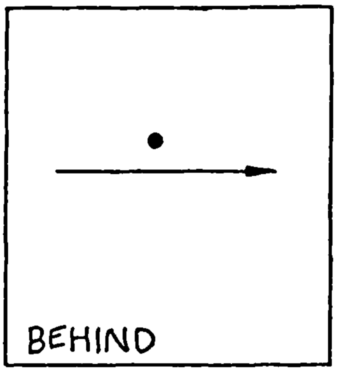
The second instrument adds dimensions of topological space (on, above, up, down between) and the third deals with external systems of reference such as the cardinal points of a compass, which also combines the first two 'flexible' systems of reference.

Figure 5: Typical errors made in Orientation of Space

Rigidity of response can be demonstrated by the following example. A child may go to great lengths in order to squeeze an arrow between the dot and the side of the frame, despite unlimited possibilities of fulfilling the request in other ways. The lack of flexibility and plasticity is readily apparent. Another type of error in the same exercise is indicative of the apparent use of self as the referent.

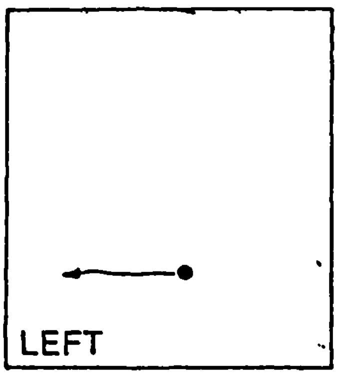


Orientation in Space I (exercise 10, page 15)



Typical error—*Orientation in Space I* (exercise 10, page 13)

The task is to describe the position of the dot in relation to the arrow. This error stems from an incorrect definition of the problem and decoding the written instruction into an action, so that the arrow is described in its relation to the dot.



Typical error—*Orientation in Space I* (exercise 18, page 16)

The task is to draw an arrow and a dot so that the dot occupies the given position in relation to the arrow. This type of error indicates the use of self as the referent and the inability to divorce spatial representation from one's own body.

Figure 5 illustrates some of the difficulties a retarded performer is likely to make on these exercises as a consequence of his rigid approach towards spatial orientation. However, once the flexibility to use representational systems has been developed the classroom examples of bridging may prove very interesting. They range from the concrete; such as being able to give someone place directions without physically taking them there, to the abstract; being aware of someone's political position (is it to the left or right of your own).

EVALUATION OF THE EFFECTS OF INSTRUMENTAL ENRICHMENT

IE promises to substantially transform the achievement goals and performance of below average and educable subnormal adolescents. Since the publication of the results (Feuerstein et al. 1979) the IE programme has enjoyed a considerable amount of attention and enthusiasm from educators of the retarded. It is therefore essential to establish whether IE can match its promise: does this remediation (based on an assessment of the cognitive deficits that impair intellectual functioning), have effects which are both durable and generalisable to other areas of the individual's performance.

In terms of IE there is a great danger that educators will attempt to run before they have learnt to walk. Bradley (1982) sees the current interest in Feuerstein's model as reminiscent of that generated by the ability training model in the 1960's and 1970's (see the deficit approach to remediation; Part 1). He exercises a welcome word of caution; our rising hopes and expectations for the model run the risk of being dashed unless we keep them in check with documented successes of research findings.

Bradley's analogy with the ability training model is not coincidental: just as those who advocated prescribed remediation on the basis of perceptual, motoric or psycholinguistic difficulties, Feuerstein's IE programme also addresses unseen process deficits which are presumed to underlie inadequate skill development. As such, it must be subject to some of the same challenges levied at the ability training models: for example, that children's processing strengths and weaknesses can be reliably and validly assessed; that they are causally related to the acquisition of academic skills; and that there are identifiable links between these strengths and weaknesses and the relative effectiveness of instruction. These points were raised by Ysseldyke and Salvia (1974). Together with the Hammill and Larsen article, published in the same year (which documented the failure of the psycholinguistic approach), it was influential in turning the tide of investment away from ability training programmes, in favour of those which had a behavioural basis.

However, before tarring the Feuerstein model with the same brush as the others, it is important to note that remedial training is not just a two-horse-race. Many of the concerns about ability training models are shared by a third party; the metacognitive theorists, with whom the Feuerstein model is most closely associated.

IE can be, but is not necessarily, given on the basis of individual ability profiles. The cognitive skills and functions which IE addresses are thought to be so commonly lacking in the repertoire of underachievers as to warrant general instruction. Ample opportunities for practise and repetition of these skills, throughout all the instruments, allow the individual to internalise them at his own speed. The deficit and academic approaches to remediation both suffer from a lack of evidence for the generalisability of the skills which they aim to teach.

Furthermore, earlier ability training based programmes were for young children and Head Start has taught us that educational intervention programmes with this population are less than satisfactory. Cognitive based programmes with older children need not necessarily share the same fate.

Ability training programmes have also been criticised by behaviourists, such as Lahey (1976), for failing to provide feedback and reinforcement. However, in IE the lessons are specifically planned to allow for discussion of the pupils' successful and unsuccessful strategies. According to Wiens (1983) developing control over one's thought processes, and the pleasure derived from that control, creates the motivation to learn. Metacognitive training may therefore suit the needs of the passive, learning disabled adolescent.

At the sixth world Congress of the IASSMD*, Bradley (1982) has taken a close look at the Israeli and American research and found it wanting in a number of respects. He makes 20 points in all but these can be collapsed under five main headings:

(1) That the diagnostic assessment procedure may not be reliable over time and different assessors.

(2) That the relationship between the spectrum of assessed cognitive defects and the concrete details of different IE instruments prepared under the model needs to be investigated and if possible proved (if IE works, does it do so for the reasons given in Feuerstein's theory)?

(3) More fine-grained reporting of the effects are essential. Gains should be related to the differential description of each individual.

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*International Association for the Scientific Study of Mental Deficiency.

(4) The researcher should assess the wider effects of intervention: on school subject learning, on daily living skills and on longer term effects such as vocational success (in more than an anecdotal way).

(5) The researcher must commit himself to the size of effect which he will consider meaningful.

The above points are useful and constructive when considering any evaluation research. However, given the recency of the Israeli and American studies it is not surprising that they have chosen to concentrate only on the major measurable effects of the pupils (although the fine-grained analysis must follow).

THE ISRAELI AND AMERICAN DATA

Although the work of Feuerstein's research institute, Hadassah-Wizo-Canada, has produced internal reports and reports for various funding bodies from the late sixties, published reports in English speaking journals dates only from 1979. A second major source of research has emerged from Vanderbilt University under the initiative of Carl Haywood (Haywood & Arbitman-Smith 1981, Haywood et al. 1982). In general the effects require at least one year to show themselves and increase during the second year. In the case of Feuerstein et al's study (1981A) the effects of IE continued to show themselves two years after the project had been terminated!

Israeli data

The primary focus of the Israeli study (Feuersten et al. 1979) was to contrast the effects of a two year intervention programme (IE) with those of a general enrichment programme (GE). The participants were 57 matched pairs (drawn from a larger sample) aged between twelve and fifteen. All fitted Feuerstein's description of cultural and economic deprivation and functioned at about three to four years behind their school peers. Detailed demographic characteristics of the sample are reported by Feuerstein (1980). The sample either received treatment (IE or GE), in a day care setting (DC) or residential (RC). The results are also recorded in terms of setting but these are of secondary importance to determining the effect of IE. The interactions between treatment and setting were limited.

In order to facilitate comparisons between the effect sizes of the American and Israeli research findings, we* have applied the techniques of meta analysis to reduce all data to the common measure of mean differences (that is the difference between the means divided by the mean standard deviation of samples). These have been calculated from the original F-tests, or from means and standard deviations (sd) where provided. The results for the Israeli sample are summarised in Table 2.

From Table 2 it is apparent that the IE group made a number of gains over the GE group. The more specific psychological tests indicate the type of reasoning that might have been affected; thus on the Embedded Figures test, of field independence, the IE group demonstrated a superior performance both in terms of the time taken to complete the test (a 1 sd lead) and in the number of correct figures (a 0.77 sd lead). Some of the sub-tests on Thurstone's PMA also reflect specific abilities addressed by IE, particularly the spatial and number tests (with effect sizes of 0.88 and 0.53 sd respectively). The IE group also appear to be better adjusted to classroom demands, as judged on a behaviour description inventory: including measures of the ability to start and conclude work independently and under supervision, persistence, cooperation, use of materials, and on negative dimensions (where the IE groups showed less instances) such as aggression, disruptiveness, deviousness and so on.

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*Dr. M. Shayer and F. Beasley

Table 2 : Israeli data for 57 matched pairs, over a two year intervention period

(Adapted from Feuerstein 1979).

Test given	Instrumental Enrichment vs. General Enrichment (N=57,57)	p.	Residential Care vs. Day Care (N=48,66)	p.	
Thurstone's PMA					Psychometric / Cognitive
Vocabulary	0.14*		0.16		
Pictures	0.05		0.27		
Numbers	0.53	(.01)	0.52	(.01)	
Addition	0.38	(.05)	0.48	(.01)	
Spatial relations	0.88	(.01)	0.13		
Figure grouping	0.36	(.051)	0		
Word grouping	0.28		0		
Perceptual speed	0.06		0		
Total score	0.35	(.01)	0.50	(.01)	
Achievement subtests					Achievement
General knowledge	0.32		0.20		
Nature	-0.03		0.36		
Antonyms	-0.31		0.12		
Bible	0.49	(.01)	0.45	(.05)	
Geography	0.17		0.61	(.01)	
Part-whole	0.15		0.08		
Geometry	0.43	(.05)	0.10		
Reading comprehension	0		-0.03		
Classroom Participation Scale 1					Affective / Behavioural
Factor A (Acting out)	-0.18		0.22		
Factor B (Unsocialised behaviour)	-0.07		0.79	(.01)	
Factor C (Immaturity)	-0.09		0.07		
Classroom Participation Scale 2					
Factor A (Interpersonal conduct)	0.36	(.051)	-0.16		
Factor B (Self sufficiency)	0.89	(.01)	0.14		
Factor C (Adaptiveness to work demands)	0.62	(.01)	-0.08		
Levidal Self-Concept					
Factor A (Failure at school)	-0.09		0		
Factor B (Motivation for learning)	-0.03		-0.05		
Factor C (Confidence in personal success)	0.07		0.13		
Embedded Figures test					Field dependence /independence
Average time	1.00	(.01)	0.02		
Total correct	0.77	(.01)	-0.17		

*Units are mean differences $[(m_1 - m_2)/s.d.]$ Negative values occur when the second sample has a higher mean.

The most noticeable - and crucial - lack of success is in the area of academic achievement. Feuerstein et al. (1979) report only two significant differences which favour the IE group: Bible (p.01) and geometry (p.05). Feuerstein has to rely on the argument that increased scores on standardised and general tests of intelligence must, in the end, result in cognitive gains in school and everyday life. This is not the case if it can be shown that IE lessons only serve as preparation for the types of intellectual tasks involved in psychometric tests. One needs to demonstrate that what psychometric tests measure is necessarily associated with the gains that the pupils, parents, and school will recognise as substantial and important qualitatively.

It is not acceptable to explain away the failure - as Feuerstein et al.(1979) do - by saying that the GE group were superior on the pre-test measures and that the IE group lost 300 hours of regular classroom instruction. In the first place the pre-test results were adjusted for in the post-test analysis. Secondly, it is tantamount to saying that if you want the pupils to succeed in traditional areas of academic performance, they must attend regular classes rather than cognitive training ones. In fairness to Feuerstein he has been the victim of his own conscientiousness: his GE control group received their own brand of enrichment in curriculum areas (it is difficult to justify doing nothing for one group of pupils when all have a common need). However, some criticisms about the smallness of effect sizes (i.e. with a differential of less than 0.5 sd) are partially blunted if one consults the data from North America.

<u>American data</u>

Data on the effects of IE have been collected from five major project sites in North America and Canada: Nashville, Louisville, New York, Toronto and Phoenix, Arizona (Haywood & Arbitman-Smith 1981). Work began in 1977 and since then the findings have been reported at international conferences including the fifth Congress of the IASSMD, Jerusalem (Haywood 1979, Arbitman-Smith 1979), the AERA* New York (Arbitman-Smith 1982) and the sixth Congress of the IASSMD, Toronto (Haywood et al. 1982). Their findings have been reported in the proceedings from these conferences, as guest chapters, and in a few journals.

The sheer scale of this study is impressive; as many as 1000 children have participated in the evaluation. In some senses it has also been a limitation: the five sites had differences in the organisation of the public school system; they employed different descriptors for the treatment populations, who also had different demographic backgrounds; and the battery of tests administered at pre- and post-test were not consistent across different sites or different year cohorts. This has led to a broad assortment of data. On the other hand, the variability has allowed Haywood's research team to make some interesting observations concerning the relative impact of IE: it does not work equally well for all persons, for all teachers and in all circumstances; there may need to be a minimum investment of between 77-100 hours of IE tuition, per academic year, before significant gains will be realised; the programme may need to be taken at a reduced pace for slow learners; and treatment effects may be multiplied if the IE teacher also takes the class for other lessons (Haywood et al.1982).

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*American Educational Research Association.

The Nashville study has been conducted with at least four different types of students: Educable Mentally Retarded (EMR), Learning Disabled (LD), Behaviour Disordered (BD) and Varying Exceptionalities (VE - students who learn poorly but whose diagnosis is not determined). Subjects from each of these categories also formed the contrast groups. All the students came from low-SES backgrounds and many were from minority groups; in the case of Nashville and Louisville 60% of the population were black. The pilot project ran from 1977-78 and since then successive one year cohorts have been introduced. The 1980 pupils have subsequently been followed through to a second year.

The same techniques of meta analysis have been applied to the Nashville data - and Louisville where the studies were combined - that were conducted on the Israeli results (where the relevant information was supplied). The Nashville sample has been chosen here to represent the American study not because the results are the best but because they have been made the most available for public scrutiny (Haywood et al. 1981, 1982, Arbitman-Smith 1982). This information is summarised in Table 3.

The early data gave encouraging indications of improvement in terms of increased scores on tests of intelligence. In the pilot year the gains across categories were significant at the .001 level. This indicates a rise of 6.42 IQ points for the IE group (from 82.84 to 89.26) as compared with an average of 2.46 points for the control groups (84.30 to 86.76). There were also significant improvements in some parts of the Primary Mental Abilities test. However, no gains were found in personality or motivational variables or on school achievement!

TABLE 3 : The Nashville data
(Adapted from Haywood et al 1982)

TEST	DATES	POPULATION	SAMPLE NUMBERS	EFFECT* SIZE	P.
Lorge Thorndike non-verbal IQ	1977-8	Nashville & Louisville E(EMR,LD, BD,VE)	16,26, 12,62.		
Grouping	"	"	"	0.64	.001
Numbers	"	"	"	0.60	.001
Analogies	"	"	"	0.48	.001
Total score	"	E vs C	116,56	0.38	.05
"	1978-9 "	Nashville VE(E vs C)	26,21	0.78	.05
Thurstone's PMA	1977-8	Nashville & Louisville			
Letter series	"	E only	116	0.56	.001
	"	E vs C	116,56	0.55	.01
	1978-9	Nashville			
Reasoning		VE(E vs C)	26,21	0.55	.064
Spatial	"	"	26,21	1.13	.001
Raven's PM	1980-1	Nashville			
Total score	"	E vs C	90,70	0.61	.001
Woodcock-Johnson non-v. IQ	1980-1	Nashville E vs C			
Broad cog. abil	"	"	44,24	0.79	.01
Verbal ability	"	"	"	0.90	.001
Reasoning	"	"	"	0.67	.01
Percept.speed	"	"	"	0.28	ns
Memory	"	"	"	1.02	.001
Piers Harris Self-Concept	1978-9	Nashville EMR(E vs C)	43,22	0.67	.05
Peabody Indiv. Achievement	1978-9	Nashville & Louisville			
General info.	"	EMR(E vs C)	44,22	0.82	.01
"	"	E vs C	190.104	0.25	.05
Key Math Diag.	1978-9	Nashville			
Arithmatic		VE(E vs C)	26,21	0.57	.06
CTBS Acdemic Achievement	1980-1	Nashville (1 class) E vs C		Estimate	
Language	"	"	10,10	0.80-1.03	.01
Social studies	"	"	8,8	0.97-1.32	.05
Math concept	"	"	10,9	0.74-0.85	.10
Math applic.	"	"	10,9	0.34-0.39	ns
Science	"	"	9,10	0.14-0.16	ns
Reading comp.	"	"	10,9	0.18-0.19	ns
Reference Skills	"	"	10,8	0	ns

EMR Educable Mentally Retarded
LD Learning Disabled
BD Behaviour Disordered
VE Varying Exceptionalities

$*(M_1-M_2)/SD$

E= Experimental
C= Control

A similar pattern emerged for the following generations of IE students. The 1978-79 and 1980-81 samples were also strongest on general measures of intelligence and particularly on those tests which tap the cognitive functions which IE focuses on: an emphasis on verbal, cognitive, and reasoning abilities (see the Woodcock-Johnson test), on spatial ability (Thurstone's PMA), and on the ability to integrate more than one source of information when data gathering (as indicated by Ravens). Although the 1980-81 cohort surprisingly failed to make significant gains on the PMA, their lead over their control groups on the Woodcock-Johnson battery was impressive (this is the first time this test had been used). The gains were not uniform across categories and the only areas where the EMR group showed significant improvement was on the information sub-test (Peabody Test) and on measures of self-image (Piers-Harris).

Unfortunately the 1979-80 Nashville data ha not been reported in a way which allows the effect sizes to be calculated, although Haywood et al (1982) conclude that the gains were not uniform across categories, the gains for IE pupils were in the expected direction 68.75% of the time. These differential gains were significant in terms of *the PMA total score* (p.001) and on several of the sub-tests; spatial (.05), letter series (.05), word grouping (.01), and numbers (.001); on Raven's matrices (.01) but <u>not</u> on achievement measures.

It is difficult to gain an accurate reflection of the gains just by looking at Table 3: not all the tests were given for all cohorts whilst other results have not been tabulated because they failed to reach significance, thus distorting the picture. One also needs to be aware of the <u>size</u> of the effect in order to interpret how meaningful it is; although the improvement of the experimental group over the control is statistically significant on the Peabody test, the differential is only 0.25 standard deviations. However, to their credit the Vanderbilt team have been diffident about claiming success.

The students' performances on the California Test of Basic Skills (CTBS) are reported for the first time for the 1980-81 sample. Haywood et al (1982) are surprised to find that the IE pupils perform significantly better in two out of seven areas measured in this test (and better in absolute terms on 6/7 measures), since these are considered to be second-order effects of the cognitive training programme. Unfortunately the two year results (1980-82) fail to provide the much needed 'academic' support for the programme. It is reasonable to expect that cognitive modifiability will take time to manifest but there must be some kind of time limit for realising a return-on-investment.

The 1981-82 results were disastrous for Nashville. There were very few positive effects of IE on any of the criterion measures and none were reported as significant. There were even cases where the control classes made greater gains than the IE ones (this was the second year of the two year project).

The Phoenix two year effects provide an extremely interesting counterbalance. Of all the American samples these children most closely resemble those of the Israeli study. They were drawn from a poor Mexican-American migrant farm working community where schooling is not a high status activity. The fact that this study was small (E=9, C=27) makes the results all the more remarkable. One effect of two years intervention (1978-80) appears to be a 15 points IQ gain (Lorge Thorndike) contrasted with 6.12 and 5.75 for the control groups. The gains for Raven's are even more dramatic; from 31-49, on a 60 item test, for the IE group as compared with the control group's gain of an average 4.72 items correct (a massive 1.63 sd differential!). At this point in the test it is not possible to score without abstract, sequential and analogical thinking. The Phoenix 1981-82 cohort, unlike those in Nashville, showed a significant increment in favour of the IE group (p.001), on Raven's matrices (the only information which is yet available).

Two years at Louisville for a small sample of twelve children who all received IE instruction resulted in similar gains on the Woodcock-Johnson sub-tests and a parallel 15 point IQ increment. These children had no controls as such, but their gains were meaningful in terms of their past achievement history (Haywood et al. 1982).

One problem of assessing cognitive modifiability is that standardised tests do not always pick up observed changes in the performances of the low functioning; e.g. they may be more attentive or more willing and so on. These discrepancies have prompted the Vanderbilt team to find alternative ways of assessing cognitive change. They are also aware of the need for a more fine-grained analysis of effects which include sensitive measures of the types of cognitive and affective factors likely to be influenced by IE (Arbitman-Smith & Haywood 1980). To this end they have been working on a number of tasks which will assess if IE training results in more efficient use of problem solving processes. These tasks include mastery (of the types of problem encountered on IE), and domain specific and domain independent measures of transfer (Arbitman-Smith 1979, 1982, Arbitman-Smith, Haywood & Bransford 1982). Maze problems have also been given to some pupils as a measure of willingness to engage and persist in problem solving activities (task-intrinsic motivation). Not unexpectedly, the IE experience appears to increase "transferability" (Haywood et al. 1982).

Post-intervention Effects (Israel)

An interesting follow-up opportunity presented itself to the Israeli research team when many of their former subjects were drafted into the army, two years after the termination of the IE programme. As part of the army induction process they were given a test resembling the American Army Alpha (the DAPAR). The performance of 184 subjects (95 IE and 89 GE) for whom earlier data existed on Thurstone's PMA were tested. The DAPAR yielded highly significant differences (p.001) in favour of those who had previously received IE instruction. The gains achieved by the IE group, immediately following the intervention, were not only sustained but continued to differentiate between the two groups after two years had elapsed (Feuerstein et al. 1981A).

The difference scores between the two groups on the PMA and DAPAR tests were plotted from the pre-test of the initial study to this final follow-up. The data closely followed a linear trend which was significant at the .000 level. The IE group showed cumulative gains over time with respect to themselves and the GE group. This is particularly significant when one considers the typical fate of the effects of an intervention programme: differences between experimental and control groups increase during and immediately following intervention, but once the project is terminated these differences fade as a function of time, in fact as a quadratic function. Feuerstein interprets these results as strong support for his claim that IE effects structural changes in the recipient which enables him to continue to learn and become modified by direct exposure to the environment; so the effects will increase with time (Feuerstein et al. 1981A).

IE in the United Kingdom

A study of IE has recently been completed in this country. It was produced by a consortium of five Local Education Authorities, through the offices of the Schools Council, who were responsible for introducing IE into the five areas (1981-83). The results had important bearings on the administrative costs and implications of IE and addressed questions such as: the suitability of the material for our pupils, problems of staffing, timetabling, teacher training, the difficulties teachers had (especialy in interpreting the teachers guides), and positive and negative experiences which arose out of the IE study (Weller & Craft 1983). Thus the work was undertaken mainly from a curriculum development point of view. Although the report was generally laudatory of the IE programme it was accompanied by little hard data. In one case at least the classroom observation by the local evaluator had not consisted of more than one visit per term. Only at the Oxford Conference, held at the end of the two years, were questions being asked as to how best to convince administrators of the need for IE.

SUMMARY OF EFFECTS OF IE

Both the Israeli and American data have revealed that IE makes a considerable impact in the area of measured intelligence: after two years of instruction those pupils in Arizona receiving IE maintain a differential gain over their control groups of at least one standard deviation (which could indicate a rise of 15 IQ points). In the case of the Israeli sample - with its enriched control group - gains of similar magnitude (0.85 sd) were only realised two years after the intervention ceased. However, IQ increments alone are not sufficient to justify the introduction of an expensive remedial programme. Where the psychometric tests measure those types of cognitive ability which IE strives to teach, those who received instruction do indeed demonstrate superior performances (for example, on Raven's matrices, some of the sub-tests of Thurstone's PMA and the Lorge Thorndike and Woodcock-Johnson non-verbal tests).

There may also be important differences in affective factors such as drive, persistence and self-perception which may not be picked-up by conventional psychometric tests but are obvious to the teacher (Haywood et al 1982). These factors may eventually lead to second-order changes in performance: the remote transfer of academic tests. The lack of support in areas of school curricula is disappointing. The Nashville team were beset by problems when the school system was reorganised; this meant many of their pupils could not be followed through and it also caused disruption to the smooth running of the programme. It is to be hoped that the important gains seen in the area of general intelligence, some 15 points for retarded pupils, will eventually be witnessed in other areas concerning their scholastic functioning.

PART 3: TEST RELATED ISSUES

The second aspect of Feuerstein's methodology is a form of clinical diagnostic assessment which is derived from the same cognitive model as the IE instruments. The use of static forms of psychometric measurement has contributed to the persistent underestimation of the capabilities of the retarded, the culturally different and those who are low functioning for a variety of social and emotional reasons. A discussion of Feuerstein's humane and optimistic approach to the assessment of low achievers, the 'Learning Potential Assessment Device' will be dealt with separately, in Part 4 of this review.

In this section some of the background issues concerning the assessment of intelligence will be raised along with a discussion of how tests based on 'learning ability' may help to overcome some of these problems. Attempts to eliminate test bias from within the psychometric tradition have proved both unimaginative and ineffective (Hegarty & Lucas 1978). IQ tests measure only the degree to which children have spontaneously acquired from their natural environment the skills and knowledge which cumulatively predict academic success. Tests of learning ability, on the other hand, can provide positive information on the child's capabilities rather than his current limitations, because they involve an explicit teaching component.

INTELLIGENCE

Intelligence has been alternately conceived of as maximally sensitive to the influence of heredity factors or to environmental ones. Stott (1983) critically examines the evidence for and against the genetic basis for intelligence, (as seen through the eyes of the main protagonists in the debate , Eysenck and Kamin), and comes down in favour of an interactionist position. Intelligence has also been viewed as stable (Bloom 1964) or as flexible (Clarke & Clarke 1984), as a general factor (Spearman 1904), a constellation of separate abilities (Thurstone 1954), or as a group of general abilities related to two distinct kinds of intelligence: "fluid" and "crystallised" (Cattell 1971).

There are many other dimensions along which the IQ debate has raged, (such as its relationship with socioeconomic status, race and achievement), although the heated conduct of the discourse has sometimes been less than intelligent. The amount of trees felled to provide paper for this dispute is already a conservationists nightmare. It is not the intention to add to this alarm by documenting the history of the mental testing debate. Amongst others, 'Intelligence: Heredity and Environment' by Vernon (1979) more than adequately covers these issues.

Feuerstein's own position is that intelligence can be defined as:

> "the capacity of an individual to use previously acquired experiences to adjust to new situations. The two factors stressed in this definition are the capacity of the individual to be modified by learning and the ability of the individual to use whatever modification has occurred for future adjustments." (Feuerstein 1979, p.76).

He makes the proviso that for certain individuals, learning how to learn, that is, modifying the cognitive structure responsible for the individual's mode of learning, must first be induced. In terms of intelligence it may be more important to know how an individual uses a particular cognitive strategy than whether he had acquired it before the test interview. Thus, a measure of 'learning ability' may be a better reflection of an individual's ability than an IQ score.

A number of personal and social factors, including 'culture' are known to influence test performance (to be discussed). Cattell's (1971) notion of "fluid" and "crystallised" intelligence may be helpful in suggesting why such factors contribute to the underestimation of ability.

The two types of intelligence, which have been isolated by a process of factor analysis, have quite distinct properties. "Crystallised" intelligence shows itself to be heavily loaded on tests where purely learned judgement skills are required, of the type encountered on IQ tests. "Fluid" intelligence shows itself on tasks involving series, classification, analogies and topology, which, because of their perceptual basis, are considered equally accessible to individuals regardless of their educational background; it has a quality which can be directed at any problem in which the answer does not depend upon recourse to stored memory solutions.

Although "crystallised" intelligence is a useful predictor of school success, and throughout the school years it tends to be correlated with "fluid" intelligence, it is not entirely satisfactory as a measuring concept (Cattell 1971). The pattern of unity is different in different schools, with different curricula and in different cultures. Furthermore, "crystallised" intelligence is influenced strongly by factors such as personality, motivation and the quality of educational opportunity. A traditional intelligence test may fail to represent the type of intelligence ("fluid") which is least sensitive to the negative influence of situational variables.

In recent years the practice of intelligence testing has come under considerable fire. The concern has been primarily with respect to the use of intelligence tests for categorising or labelling individuals in order to set long-term educational goals, matched to their presumably fixed abilities (as indicated by the test results).

All too frequently the purpose of assessment seems to be solely administrative. In the field of mental retardation, however, assessment techniques which lead directly to enhancing procedures are needed.

ARE IQ TESTS UNFAIR?

The main justification for using IQ scores in the immediate practical sphere is to predict educability. Test results do correlate highly with performances in school and beyond, which may account for the durability of the tests given their current unpopularity. However, except in cases of severe subnormality, it is also true that the earlier the measure and the longer the period over which IQ is predicted, the less reliability the measure has. This declining accuracy of prediction over time reflects genuine developmental and personality changes (Clarke 1978). Moreover, IQ's serve as poor predictive measures for the latter adjustment of the retarded (Brown & French 1979). Single trial measures typical of most IQ tests often bear no relationship with the much higher scores which can be obtained after training (Clarke & Clarke 1973).

Few would dispute that psychological tests and the theories underlying them are exempt from criticism. Mental testing has long been the subject of intense public controversy. Although Jensen's book 'Bias in Mental Testing' (1980) was written as an antidote to what he calls the 'anti-test syndrome' it nevertheless summarises the breadth of current dissatisfaction with psychometric tests:

> "The chief criticism directed against 'IQ tests' are that they are culturally biased against minorities; that the test items appear schoolish, defective, or trivial; that psychologists cannot define intelligence and therefore cannot measure it; that the tests measure nothing but the ability to do well on similar tests; that the

> tests fail to measure innate capacity; that the norms are unsuitable for minorities; that the IQ is a measure only of specific knowledge and skills acquired in school or a cultured home; that the IQ is inconstant from early childhood to maturity; that the test scores are lowered when the tester is of a different race; and that the tests and test results have been misused." (Jensen 1980, pp.23-24).

One must have sympathy with some of Jensen's counter-criticisms. He rightly points out that much of the popular attack is emotional, ad hoc and self-contradictory, and it generally lacks consideration of the type of psychometric information needed for the proper evaluation of the tests.

On the other hand, protagonists in favour of dynamic tests share valid reservations about the limitations generated by traditional tests. IQ tests do not indicate why a particular subject did poorly and, not surprisingly, unidentified problems are likely to remain unsolved (thus present performance may well be a good predictor of the future!); they say nothing of 'learning ability'; they overlook the influence of extraneous factors and the resulting aggregate IQ score oversimplifies the child's individual pattern of strengths and weaknesses. As to the question of the estimation of 'innate' capacity Jensen would argue that quantitative genetics already exists as a scientific way of determining it. This is of little consolation for the child unable to give his best in the Assessment room.

The issue in this thesis is not that IQ tests are inherently 'evil' or that they have no role to play but rather that they may underestimate the capabilities of low-functioning individuals. Standardised tests, when used correctly, overcome the vagaries of informal assessment; they make the observations of different examiners quantifiable and consistent (Warren 1977). They are also an economic way of obtaining a wide range of information that can assist in the planning, execution and evaluation of teaching programmes. The danger is that, over time, it is concluded that what is not measured does not exist.

Ornstein (1976) has made an intelligent contribution to the IQ testing debate. He remarks that the fact that disadvantaged students do poorly on IQ tests does not mean that the tests are unfair or biased. The scores reflect the unfairness of social and environmental conditions and these conditions, like the test, are fairly valid for predicting school success. The solution is not to deny the child's deficiencies, or to abolish the tests that highlight them, but to eliminate the educational and social inequalities that give rise to them. This is precisely what advocates of 'dynamic' modes of testing aim to achieve within the testing session: the opportunities for success are equalised for different individuals since the tasks are based on the ability to learn new material. Problem solving strategies, which are not part of the subject's existing repertoire, may be supplied by the examiner who is mainly interested in seeing how this information is used.

'CULTURE FAIRNESS' IN ASSESSMENT

The impetus to develop tests of learning ability (including Feuerstein's own Learning Potential Assessment Device), has resulted from the realisation that culturally diverse children suffer in comparison with the indigenous population for reasons which may be unrelated to their ability (Feuerstein 1979, Hegarty & Lucas 1978).

The fact that certain ethnic groups are over-represented in classes for special education is widely documented and rarely disputed. The use of unjust and unsuitable tests are frequently blamed for this unfortunate state of affairs. For some, this amounts to a charge of overt racism within the school (Hilliard 1980). Complaints of test discrimination, in relation to culture, generally fall into three categories: in the main they are designed and scored in accordance with the indigenous, white, middle-class values which may be alien to some subcultures; secondly, given the racial bias of the tests, objections have been raised as to how the information is used; and lastly, minority children seem to suffer more than their middle-class counterparts from 'atmosphere' variables during the course of the test (Bailey & Harbin 1980).

It would be difficult, if not impossible, to divorce the effects of culture from cognition. Man is a product of his experience and these experiences vary between and within different societies; they reflect affluence, opportunity and social values. A comparative psychology of cognition may be one answer, but here is not the appropriate place to expand on the individuality of the cognition of certain cultures. The interested reader is referred to Cole and Scribner's (1974) 'Culture and Thought: A Psychological Introduction'. However, this book does not address the question of wide variability of performance within a culture for children of similar circumstance. Feuerstein's (1980) theory of mediated learning experience, and differential exposure to it, could account for such differences.

Historically speaking, the most common strategies employed by test developers to eliminate bias have been to translate existing tests from one 'cultural language' to another, or, to minimise the verbal and numerical components of the test. Examples of the latter include the Culture Free Intelligence Test (Cattell 1950), and Raven's Coloured Progressive Matrices (Raven 1962). Verbal and number tests are however better predictors of educational achievement. Research consistently shows that despite attempts to 'desocialise' the tests, children from low income and minority families usually score lower than the white middle class (Bailey & Harbin 1980).

Other alternatives to the cultural problem have included the use of adaptive behaviour scales or special group norms but both are controversial: Bailey and Harbin (1980) report that the former can lead to under-representation of minority children in special educational placements and the latter, which confines a child to a particular reference group, may actually work against his chances of social mobility.

The failure of minority and low-SES children to equalise performance has not been universally attributed to test discrimination. Jensen's 1969 paper has been widely associated with the view that the inferior performance of blacks and low income families is a reflection of their true genetically determined abilities. Yet, on the basis of his work with Indian Culture, Das (1973) has concluded that birth into a higher caste has no absolute advantage in terms of cognitive abilities. Economic prosperity, on the other hand, was more important than high class birth order in providing such an advantage. One must be careful not to confuse the influence of culture with that of poverty!

Test 'atmosphere' variables which impede test performance are not, however, a prerogative of the poor or culturally different; although there is some evidence to suggest a higher prevalence of extra-intellectual handicaps amongst these groups (Coleman 1966, Goldstein et al. 1978, Henderson 1980). The effects of anxiety, impulsivity or low motivation are generally deleterious in terms of test performance regardless of the individual's race or socioeconomic status. Advocates of 'dynamic' testing, including Feuerstein (1979), believe that a substantial proportion of the negative influence of test situational variables can be eliminated by this interactive mode of testing.

CORRELATES OF LOW TEST PERFORMANCE

Until the 1960's individual differences in cognitive processes were thought to mirror basic differences in IQ. More recently personal and social factors have been explored as possible contributors to the variance. Different subgroups patronise different linguistic codes (Bernstein 1961), and although the preferred mode cannot be assumed inferior (Labov 1970), the tests are typically constructed in the language of the middle class. This raises the possibility that certain 'cognitive styles' may be incompatible with test taking activities (Cohen 1969).

Survival skills necessary in the street may be in sharp contrast with those required in the school; impulsivity is for some an expression of moment to moment, hand to mouth living but it is maladaptive as far as the school is concerned. Poor perceptions of personal efficacy (Wiens 1983), 'learned helplessness' (Dweck & Reppucci 1973), anxiety (Culler & Holahan 1980), and impoverished motivation (Zigler & Butterfield 1968) are all strongly associated with disappointing performances.

Zigler, Abelson and Seitz (1973) hypothesised that the exceptionally low IQ scores of young economically disadvantaged children is more a reflection of their fearfulness of the unfamiliar testing situation than any cognitive or linguistic deficits. This 'motivational' interpretation of poor performance would predict that familiarity with the examiner would result in significantly greater test-retest gains in scores for disadvantaged children. Indeed, Zigler et al. (1973) reported a ten point retest increment for such children whilst no such differences were evidenced in their non-disadvantaged group (who presumably had fewer fears to allay).

Studies of the reflective-impulsive psychological dimension support the view that it is correlated with test performance when response uncertainty is involved, of the type encountered in many IQ tests. When tests are given in the conventional way, the examiner is obliged to note the subject's first choice of response. The 'concrete' record of the interaction shows only that many errors were made but the resulting low-level score may not represent the subject's 'true' ability. An impulsive conceptual tempo is therefore a considerable handicap to a child faced with a psychometric test.

A great deal of work on the impulsive disposition has been conducted by Kagan and his associates, both in developing diagnostic tests and in establishing whether or not the trait is modifiable (see Messer 1976 for a review). Kagan, Pearson and Welch (1966) found that children trained to be reflective increased their response latency significantly although it did not improve their accuracy scores. This problem has been dealt with previously.

Instead of forcing subjects to delay their responses, in the vain hope that they will spend the time considering alternatives, it would seem far more efficient to <u>teach</u> them the skills that would enhance such an analytic approach. Consistently positive results, in terms of response times and error rates, have been obtained when impulsive children are trained to use problem solving strategies (Egeland 1974, Messer 1976). A deliberate part of Feuerstein's testing methodology is to correct such 'deficient' cognitive strategies during the actual test session which then enables the subject to perform optimally (see Part 4).

Meichenbaum and Goodman (1971) taught efficient scanning strategies to two groups of impulsive pupils. One of these groups was told to rehearse the task instructions aloud to themselves (to encourage attention and internalisation). As a result of the training both groups increased their response times but only the self-instructed group improved on their error scores.

CAPACITY VS COMPETENCE?

The fact that test performance can be influenced and depressed by a variety of non-cognitive variables would seem to lead to a distinction between what a person can do (his capacity), and what he does do (his competence). The notion of untapped 'ability' is pertinent to all diagnostic assessment situations, particularly for the low functioning: that these children have a capacity beyond their currently available competence is the underpinning philosophy of all forms of remedial education. Bortner and Birch's (1970) paper has been of seminal importance in integrating the scattered lines of evidence concerning 'capacity' that have emerged from British, American and Russian laboratories. Their conclusion is as follows:

> "Our consideration of the relation between cognitive capacity and cognitive performance in mentally subnormal children, as well as in normal children and experimental animals, permits a general conclusion. It is clear from all these data that performance levels under particular conditions are but fragmentory indicators of capacity... Glaring differences occur in the estimates of potential when meaningful alterations are made in the conditons of performance." (Bortner & Birch 1970, p.742).

Birch and Bortner's interest in 'capacity' sprang from their earlier work (1966) on the question of the degree to which children possessed concepts which were not available for use when they performed under ordinary free-field conditions. They found that by manipulating the test conditions higher-order mental abilities were revealed in their sample than would otherwise have been apparent. This was also true for brain-damaged individuals (Bortner & Birch 1970). Similarly, Mehler and Bever (1967) found that the typical response of 'non-conservation' of number in their young sample was not replicated when the response called for was eating: here the subjects demonstrated conservation in action!

The emphasis of the British approach to highlighting the distinction between capacity and performance emerged from an investigation of the work habilitation and productivity of retarded individuals. Clarke and Hermelin's (1955) study of the trainability of adult imbeciles illustrates this generation of research. The prevailing expectations for the six severely retarded individuals in their study were extremely low. Nevertheless the exceedingly low initial levels of performance that these imbeciles displayed bore little relationship with the much higher levels obtained after structured training. Once learning had commenced they proved quite capable of completing tasks, for which they could be paid, in a sheltered industrial workshop. In theory all of the tasks they were given should have been beyond their competence. This underscores the point that the 'once-only' measures of performance of typical IQ tests, provide very unsatisfactory indicators of ability for retarded individuals.

The American work has focused on the motivational and non-cognitive aspects of test performance (for example, Zigler & Butterfield 1968). It goes without saying that if a child's performance is inhibited the test fails to reflect his true 'capacity'.

Russia's contribution to the debate has been directly influenced by the work of Vygotsky, written before 1934 and posthumously translated into English. In his innovative (1978) book, Vygotsky differentiates between two simultaneous developmental levels in the child: the actual developmental level (which represents already completed developmental cycles), and the 'zone of proximal development' defined as "...the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance..." (Vygotsky 1978, p.86).

According to Vygotsky developmental processes do not coincide with learning processes, rather, they lag behind and it is this sequence which results in the 'zone of proximal development'. The zone represents those functions that have not yet matured but are in the process of maturation; functions that are currently in an embryonic state.

The 'zone of proximal development' is a powerful concept in developmental research and one that can markedly enhance the effectiveness of the application of diagnostic assessment to educational problems. By this method one can take account of processes which are already completed as well as those which are presently being formed. Vygotsky (1978) has not only challenged the assumption that what a child does on his own is the best measure of his ability but he also provides the means to test the assumption (above).

All dynamic testing methods, testing to the limits, owe a debt to Vygotsky's distinction. The extent to which a child can use adult assistance differentiates between children of the same IQ but with various reasons for their poor performance: impoverished educational experiences or genuine inability. According to Luria (1961,1971), a student of Vygotsky, what the child does today with help becomes the basis of his independent activity tomorrow. Measuring his response to adult guidance therefore gives a prognosis for the child's developmental potential.

The capacity/competence differential has ignited discussion as to the failure of IQ tests to reflect a person's capabilities and tests of learning ability have been suggested as an alternative. However, there are problems with using notions such as 'learning ability', 'capacity' or 'potential'. Some have argued that since we cannot measure them directly we should confine our discourse to performance: the vehicle through which they are expressed. This avoids the need to make inferences about abilities which may or may not exist, but what is inferred can be real and it can be of greatest significance in practice. To deny the existence of abilities, dispositions, or whatever, would severely restrict the possibility of understanding human behaviour.

Cronbach (1970) does not view the learning ability construct as either satisfactory or helpful. However his comments are addressed to intelligence tests, as tests of learning ability, and not tests constructed on the notion directly. In this case one would have to agree with him that IQ tests do not measure learning ability. His objections to the trainability of learning ability and its lack of universality across different learning situations have been dealt with by Hegarty and Lucas (1978). These authors would have reservations about any learning theory which claimed to be unidimensional: there are many kinds of learning situation and it is understandable that competence in one area does not guarantee competence in another. In the psychometric tradition abilities are thought to be relatively independent of each other.

If a subject's performance on a learning ability task can be improved with tuition, as Cronbach protests, then calling it 'learning ability' might be a misnomer: the construct is related to achievement rather than ability. Hegarty and Lucas (1978) attempt to resolve the difficulty by asking the question: is the improvement a result of improved ability or is it because ability is structured at different levels which require others to be actualised before they can be effective? They make the distinction between 'actual' and 'potential' abilities. For example, one would need to be able to play the piano well (achievement related) before being able to demonstrate an inspired interpretation of Bach (potential related). The latter depends on the former for expression but not for its existence.

Feuerstein (1979, 1980) makes the same distinction between 'potential' and 'ability' (or competence). The provision of mediated learning experience in Instrumental Enrichment may furnish the individual with skills that are they key to unlocking dormant 'potential'. For Feuerstein the point of IE training is that the ability to learn efficiently is trainable!

Two issues have been alluded to: the first is that a meaningful distinction can be made between capacity and competence. The second suggests using 'learning ability' as a means of investigating the difference. The Learning Potential Assessment Device, as the name suggests, utilises such an approach (Feuerstein 1979).

Doubt has been expressed as to the feasibility of measuring ability performances and attainment performances separately but this, in part, is just a war of words: if a child, with adult assistance, demonstrates competence at a level previously unavailable to him then this is indicative of a capacity which can be exploited with tuition.

Unfortunately little is known about 'learning ability' as a theoretical construct; how it is structured and how it relates to neighbouring constructs (Hegarty & Lucas 1978). Perhaps we should be asking whether the learning ability construct is useful and whether tests of learning ability say anything about individual differences that intelligence tests do not.

IS THE 'LEARNING ABILITY' CONSTRUCT USEFUL?

It is difficult to spell out the precise nature of the relationship between intelligence and learning ability. The two are often taken to be synonymous although they are not. One can assume a child who learns quickly and well is intelligent but the converse is not automatically true. The confusion reflects a genuine complexity; obviously the ability to learn is involved in the actualisation of intelligence, and vice versa, and it would be difficult to give a satisfactory account of either individually.

Tests of learning ability are not without problems but they may help to overcome some others that are associated with intelligence tests. They are not intended to replace them in any general way. Hegarty and Lucas (1978) have outlined several areas where learning ability tests could provide valuable information: firstly, there is an obvious relationship between school achievement and the ability to learn. Learning ability tests demonstrate a child's capacity to profit from instruction and therefore the information is of direct relevance to any teaching situation.

Secondly, these tests attempt to reveal 'capacity' as distinct from prior achievement. Because IQ tests seldom involve an explicit teaching component they are obliged to draw heavily from a common core of experience for the test items - these inevitably reflect the majority 'culture'. On the other hand, tests of learning ability, as a requirement, are based on material which is quite different to anything the child is likely to have encountered. Furthermore, should any differential familiarity with the type of test item exist, particularly since the advent of the educational toy, the effects are reduced by providing practise opportunities. The child's misunderstandings are corrected at this stage.

There is also evidence to suggest that learning ability tests can discriminate between children with uniformly low IQ's. The learning ability of three different types of children was investigated by Jensen (1963). These included EMR with IQ's between 50-75, average (IQ's of 90-110) and gifted children (IQ's of 135+). Children of average and high IQ returned average and high ability scores, so for them IQ served as an adequate predictor of capacity. The EMR group, however, showed considerable variability with respect to learning ability: their scores spanned the whole range. In fact the two fastest learners in the entire study had IQ's of 147 and 65! Although the learning scores correlated with IQ at all three levels the variability was greatest amongst the retarded. Misclassifications were only found in this group.

It was also the EMR group who made the greatest gains as a result of practise. Tests of learning ability may therefore be particularly suitable for the assessment of low-functioning individuals.

Interestingly enough, Jensen (1963) hypothesises that the fastest learners in the EMR group are not really retarded in the primary sense but at some point in their development they failed to learn the kinds of behaviour which are a necessary basis for school learning and for the kinds of knowledge and skills tapped by IQ tests. Feuerstein's notion of the lack of mediated learning experience is a compatible explanation for inadequate skill development (Feuerstein 1980). Moreover, once provided with encouragement, practise and the appropriate skills Jensen's 'secondarily' retarded subjects were able to demonstrate increased competence (Jensen 1963).

THE LEARNING ABILITY CONSTRUCT IN USE

The gradual introduction of learning ability tests mirrors a trend in the practice of educational psychology towards a 'process' orientated approach which fulfils a diagnostic/prescriptive function rather than a classificatory/descriptive one. Despite the ambiguity, studies based on the learning ability construct may have a significant role to play in educational assessment and informed intervention. One of the most extensive programmes to exploit the learning ability idea has been Feuerstein's assessment and remedial work with low-functioning adolescent immigrants in Israel (Feuerstein 1979,1980). His work on the Learning Potential Assessment Device will be discussed in Part 4 of this review.

For a variety of historical and social reasons standardised tests have been criticised and at times outlawed by the Soviet Union. At the same time the Russians have a major commitment to special education. In recent years there has been a growing interest in reliable methods for the differential diagnosis between the 'temporarily delayed' (non-organic) and 'oligophrenic' (organic) forms of retardation. The Russians have concentrated on the development of clinical diagnostic tests to evaluate differences in 'learning potential' (derived from Vygotsky's theory of the 'zone of proximal development'). It is argued that the main difference between a learning disabled and a truly retarded child lies in the width of their 'zones of proximal development'. A wide zone is indicated by a reduction in the amount of adult prompts offered to the child during the course of the test and the pupil's subsequent demonstration of his ability to transfer this learning to new tasks. The view is that intellectual development will be maximised if training is directed towards the upper end of the observed zone of next development. Unfortunately, in common with many second-hand reports of Soviet psychology, there is a lack of specific details (see Brown & French 1979).

Sutton's (1977) 'teaching experiment' in an ESN primary school in Birmingham was designed to see whether the Russians' technique (above) could be used to separate children into 'temporarily delayed' or 'oligophrenic' groups. In 109 out of 125 cases he found that the children's responses to teaching did correspond to an independent diagnosis of impairment. Feuerstein (1979) would however be opposed to attempts to set low educational goals for the 'oligophrenic' group based on their 'permanent' limitations.

The work of Budoff and his associates has been particularly important in illustrating the need for the 'learning potential' approach for the assessment of disadvantaged individuals. Budoff advocates a 'test-teach-test' paradigm; the rationale being that since these children demonstrate competence in the playground their inability in the classroom is, amongst other things, due to the lack of opportunity to develop middle-class problem solving skills. By introducing a training element into the test such an opportunity would be provided. Whilst the pre-test measure indicates the subject's present comptence, the post-test score reflects his trainability or 'potential' (Babad & Budoff 1974). This discrepancy is hypothesised to be largest for children from disadvantaged backgrounds.

Budoff et al have investigated the 'teaching' paradigm using a variety of different learning tasks including their own Series Learning Potential Test, SLPT, (Budoff & Friedman 1964, Budoff &

Hamilton 1976, Babad & Budoff 1971, 1974). A general distinction which he and his associates make is between children who are educationally retarded and those who are mentally retarded. This is similar to the distinction made in the Soviet Union. The SLPT differentiates between three groups of children according to their responses to coaching: gainers, non-gainers, and those who are high scorers without coaching.

Sparse social data suggests that the gainers tend to be from poor homes and disorganised family units whilst low achievers from middle-class backgrounds are mainly non-gainers, or mentally retarded, since environmental rearing conditions are already optimal for these children (Budoff 1967). The 'gain' ratings have been used to predict succes within a classroom curriculum (Budoff et al. 1971) with greater success than IQ measures.

A very interesting study by Babad and Budoff (1974) used the SLPT to confirm a considerable potential to reason amongst IQ-defined retardates. (These tasks require <u>conceptual</u> rather than rote learning). The SLPT was administered three times to 126 children of three ability ranges: bright (of mean IQ 113, N=64), dull-to-average (with IQ's between 80 and 90, N=37) and subnormal (with IQ's below 80, N=25). Training in problem relevant strategies followed the <u>second</u> administration. This meant that a <u>practise</u> effect, that is the difference between the second and first scores, as well as a <u>training</u> effect (the difference between the third and second scores), could be measured.

All groups gained from repeated administration, however, the dull pupils showed greater practise effects than both the subnormal group ($p < .01$), and the bright group ($p < .001$). Likewise, all groups benefited from training but here the results were different: both the subnormal group and the dull group gained significantly more than the bright group ($p < .005$ and $p < .025$ respectively).

The fact that the high-IQ subjects made the least gains was not due to 'ceiling' effects but because they were already performing maximally on the pre-test; their post-test scores were at least two standard deviations below the ceiling (Babad & Budoff 1974). Whilst the dull group were able to benefit from either practise or task-appropriate training, the subnormal sample seemed to profit most from the training. This is in line with our expectation that low-functioning individuals have difficulty benefiting from direct exposure learning situations but can make gains when the learning situations are structured. More than one third of the subnormal group surpassed the pre-test mean of the bright group, despite a 41 point difference in the average IQ's of the two groups!

A further study (reported in the same paper) was carried out to test the predictive power of the SLPT with that of an intelligence test. The criteria for success was school achievement as measured by teacher ratings on an eleven point scale. Whilst the IQ and learning potential measures were almost identical for the bright group, for the two lower ability groups the learning potential predictions were actually superior. This indicates the greater sensitivity of learning potential measures for low-ability pupils (Babad & Budoff 1974). These results parallel Jensen's earlier (1963) findings that low-achieving children are not a homogenous group with respect to learning ability.

Dynamic forms of testing may influence both 'procedural' variables, such as visual scanning behaviour, and 'orientational' variables, such as anxiety, in a way that leads to higher levels of performance. Bethge et al. (1982) tested this hypothesis on a group of 72 children, aged approximately 8 years 7 months, who were matched for ability and tested on the Raven's matrices under one of three conditions: standard, as the manual recommends; ongoing feedback and strategy verbalisation. They found that even after a <u>single</u> administration significant differences between the groups had emerged ($p < .02$). Not only did the verbal and elaborated feedback conditions reduce the negative influence of non-cognitive factors, (the differences between these and the standard condition were significant at the .01 level), they also resulted in more efficient scanning procedures, as measured by eye movement analysis, which are pertinent to the success on this type of reasoning task.

Bethge et al.'s (1982) results therefore not only demonstrate that dynamic forms of testing can positively influence pupil performance, but they also give some indication of <u>how</u> this may occur.

The National Foundation for Educational Research (NFER 1978B) has developed a test of children's learning ability as a means of coping with the problems of multicultural assessment. The ground work for this test was based on a previous study, conducted by Judith Haynes (1971), on the learning ability of 125 young punjabi-speaking Sikh children. Haynes had found that her learning ability battery predicted moderately well with subsequent school achievement and in any case did so better than the performance subscale on the Wechsler Intelligence Scale for Children (WISC). Hegarty and Lucas (1978) were on the NFER research team and they sought to investigate whether the technique had broader, multicultural, applicability since Haynes' sample were all Sikh children from the same London area.

The NFER test of children's learning ability (1978B) assesses the pupil's ability to respond to a structured teaching situation. The individual battery was administered to a national sample of 386 West

Indian and Pakistani children, (average age 7 years 9 months), along with the short form of the WISC. Twelve months later tests of attainment in vocabulary, mathematics and reading were given to these pupils so that the predictive validity of the NFER test could be compared to that of the WISC. A consistent picture of superiority of the tests of learning ability emerged as predictors of the criterion or 'attainment' scores (Hegarty & Lucas 1978).

The references cited in this section are illustrative rather than exhaustive; they emphasise where and how tests of learning ability can be used when traditional tests are unsuitable. The work of Bethge et al. (1982) indicates how dynamic assessment can incorporate human factors into the analysis of cognitive performance. It is in the area of multicultural assessment and the assessment of low-functioning individuals, however, where the practical significance of these manipulations in the test conditions are most clearly felt. The use of learning ability tests confirms a considerable ability to reason amongst low-IQ children which is not indicated on standard measures of intelligence. Children who lack abstract problem solving skills, never having been taught them, benefit considerably from this approach.

The literature indicates a need for more sensitive tests of the abilities of the low functioning than IQ tests can provide. Feuerstein's own work on the assessment of learning potential can now be introduced against this background. The LPAD was however developed quite independently from all other work. The LPAD, more than any other test of learning ability, maximises the emphasis on 'processes' rather than 'end product' in the test situation. His method not only results in a description of the nature and locus of impairments, it also indicates those areas of performance which are most accessible to change.

Since Feuerstein's test is to be used in the present study it is necessary to look at it in some detail in order to give an indication of the uniqueness of the testing methodology. It is also necessary to examine, as far as possible from the literature, whether or not LPAD can meet its stated claims.

PART 4: THE LEARNING POTENTIAL ASSESSMENT DEVICE

THE LEARNING POTENTIAL ASSESSMENT DEVICE (LPAD)

The failure of psychometric tests to meet the assessment needs of the culturally different and socioeconomically deprived child has several side effects: it supports the pessimistic attitude concerning this population's ability to accede to higher levels of sociocultural integration because of the limitations set by their low level of functioning; this negative stereotype may become self-fulfilling in that it determines the amount, nature and quality of educational investment; lastly, it influences, negatively, our understanding of the nature of intelligence and the dynamics of its development. The Learning Potential Assessment Device differs fundamentally from conventional tests in several respects: the structure of the test; its emphasis on 'process' rather than end point; the nature of the test interview; and the way in which the results are interpreted (Feuerstein 1979).

The need for this type of test arose from Feuerstein's confrontation with culturally different and deprived children and adolescents who came to Israel after the war. In his role as Director of Psychological Services for Youth Aliyah, (a Jewish non-governmental organisation responsible for the resettlement of these immigrants), he was in charge of the assessment and rehabilitation of these individuals, many of whom had been rescued from persecution. For these children regular intelligence tests were wholly inadequate. It became necessary to look beyond their low scores at the underlying etiology of their difficulties and at the possibility of reversing their cognitive impairments (Feuerstein 1980). However in order to assess 'modifiability' it is first necessary to produce changes in performance. The 'static' psychometric type of testing does not permit the required manipulations in the test administration.

'The Dynamic Assessment of Retarded Performers' (Feuerstein 1979) documents numerous success stories of adolescents previously characterised as mentally retarded who, as a result of this opportunity to demonstrate hitherto unrecognised 'potential', went on to become competent and adjusted adults.

LPAD is not a miracle cure for all ailments and there have been occasions where it has not been helpful, particularly in cases of multiple handicap and where there is little or no communication because of emotional disturbance. However, this is counterbalanced by the hundreds of cases which Feuerstein (1979) reports are in the files at Jerusalem, where clinical individual LPAD assessment was decisive in restreaming children back into the regular educational framework. Chapter 6 of his book outlines a number of illustrative cases where both non-organically and organically impaired adolescents, and those with possible psychoses or emotional disturbance, have responded to this form of assessment. When followed up as adults many of these people held regular, responsible and sometimes professional jobs.

THE NATURE OF LPAD TESTING

> "The LPAD is geared towards producing changes within the individual during the testing situation in order to permit an ongoing assessment of that individual's ability to learn and change relative to his/her own initial levels." (Feuerstein, Miller, Rand & Jensen 1981B, p.203).

There is a profound conceptual difference between tests constructed in accordance with psychometric principles and those which reflect 'dynamic' ones. The implications of the switch from a 'product' to a 'process' orientation are far reaching both in terms of the methods of assessment and the solutions arrived at concerning the low functioning. Their respective emphases are on predictability (stability) and 'modifiability' (potential for change). A dynamic approach demands that the examiner forfeits his neutral role of 'passive recorder of events' in favour of a teacher-pupil dyadic relationship: this is based on mutual feedback and cooperation and involves a variety of teaching and reinforcing strategies, followed by ways to evaluate their efficacy. The relaxation of the rigid relationship between the examiner and examinee may be particularly important to the disadvantaged child or those who are used to failure.

The intensive interaction involved between 'teacher' and 'pupil' in the LPAD approach would automatically contaminate the results of a psychometric test because it interferes with the measurement of stable charactertistics; that is, those which are insensitive to environmental influence.

The examiner must be careful to ensure that only the most minimal help (mediation) is offered to enable the child to solve the problem. The individual's capacity to benefit from the intervention is then indicated by his application of the recently acquired learning to new problems. The changes produced in this highly charged test session are not expected to last but they do serve to illustrate a 'potential' that is there to be exploited.

A further point of departure from conventional tests occurs in the way the results are evaluated. Traditionally tests are discontinued, for economical reasons, after a certain number of failures has been reached. Any unexpected successes after this point are seen as unrepresentative and are thus excluded from the final score. The reverse happens in LPAD: these 'peaks' are explored as potential reservoirs of untapped ability. Furthermore, a score which has been summarised into some form of average grade masks any differential abilities in the employment of cognitive skills.

THE TEST SITUATION

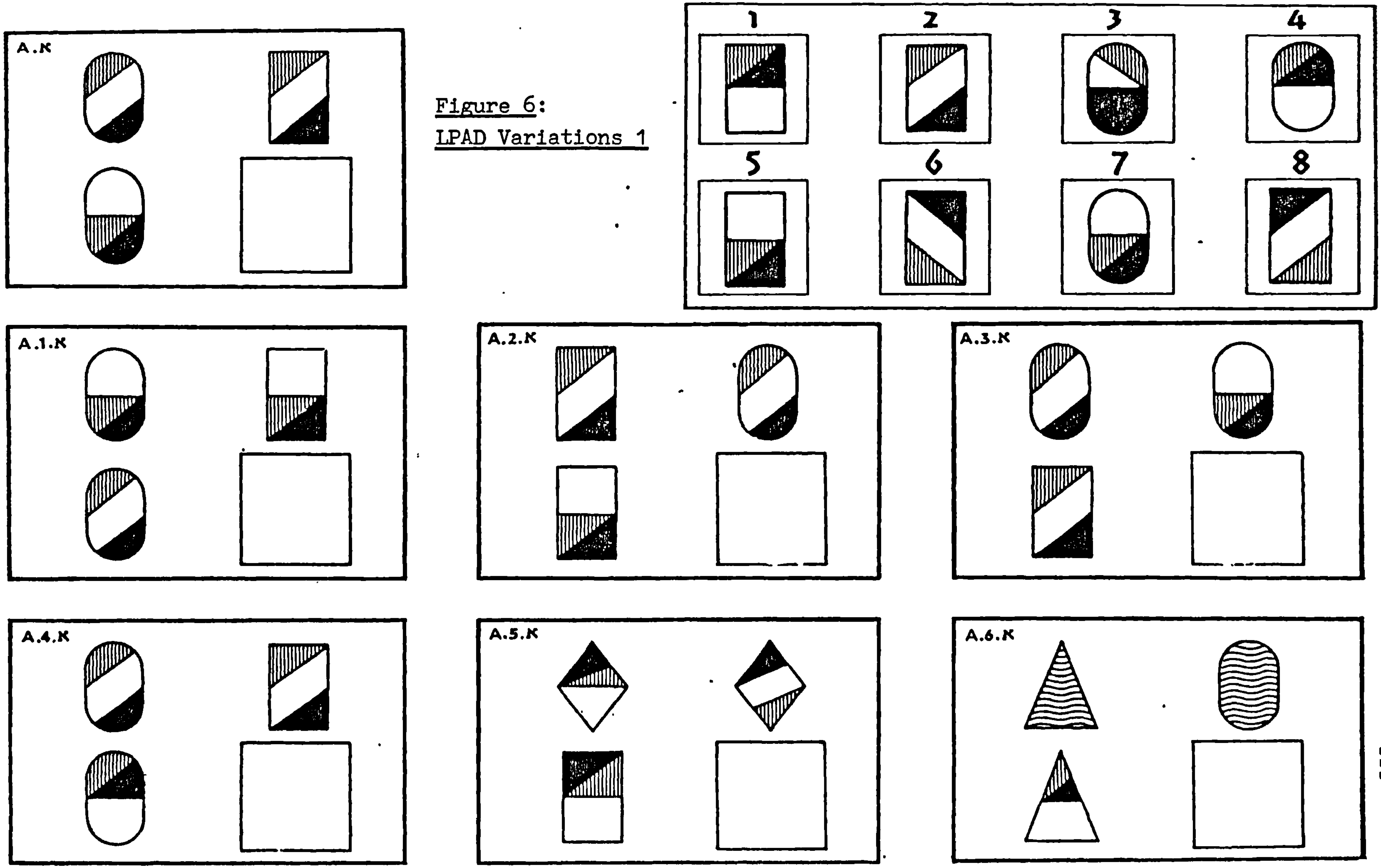
The test structure is geared towards the assessment of 'modifiability'. That is to say the concern lies with the ease of learning and the amount of examiner intervention needed to bring about this change in pupil performance. As a by-product the examiner also gains an insight into the child's cognitive strengths and weaknesses. The dialogue continues between the two even if the answer given was correct; this not only ensures that the correct answer was not obtained by chance but it consolidates the learning and, in turn, this enables the subject to correct his own errors and go on to solve additional tasks.

The training aspect of LPAD testing involves the correction of the prerequisite cognitive functions which Feuerstein believes underlie successful performance. This is not just an euphemism for teaching success strategies. If the individual demonstrates difficulties in accurate and precise intake of data, which corresponds to the Input phase of the cognitive map, (Table 1, page 48), the examiner must ensure that this aspect of the task is properly accomplished. If on the next task, in which only the specific content of the problem has been changed, the examinee shows improvement then it is legitimate to conclude that the potential to learn is present.

Figure 6 is an example of the LPAD Variations. The format of the problem is similar to other IQ test materials, for example Raven's Progressive Matrices, the difference is in the presentation.

In the training problem AN (Figure 6) a European pupil might

Figure 6:
LPAD Variations 1



think the aim of the task is to match his solution to the lower left portion of the matrix, generally response alternative 7 is given. Strictly speaking this answer is wrong but before making any fallacious conclusions about 'ability' it is essential to find out, by asking, if he has understood the problem demands. Only when this has been established would it be reasonable to judge the individual's ability to integrate 'two sources of information' when solving matrix problems. A simple check would then be to cover up the response alternatives and ask the pupil to describe what he thinks the answer will look like. The following problems in Figure 6 are increasingly novel variations on the same theme and the pupil demonstrates mastery by applying the 'two sources of information' relationship to these problems.

The next series in the LPAD Variations introduces a third dimension. In addition to monitoring the change in the shape and pattern the pupil must also be aware of changes in the orientation of the shapes and apply the equivalent rotation to his own answer, and so on. Other members of the test battery include: Organization of Dots, Numerical Progressions, the Representational Stencil Design Test, (which are all also part of the Instrumental Enrichment Programme), the Plateaux I and II, the Positional Learning Test, Rey Complex Figure and Associated Picture Recall (see Appendix 1D for some examples). New tests are continually being added to the established battery. Feuerstein's (1979) book provides more details of some of these tests but it is not intended to be a manual for the LPAD testing procedure. The new examiner's manual will shortly be published (Feuerstein et al. 1984).

Particular LPAD tests are sometimes very efficient in highlighting certain cognitive deficiencies and the experienced clinician should be able to use the tests diagnostically. If the suspicion concerned 'blurred and sweeping perception' (input phase) then the Representational Stencil Design Test would be a good instrument to use. If 'conservation of constancies' appeared to be the problem then the Organisation of Dots test would pick this up. In a clinical situation it would be advantageous for a child to be seen more than once so that a set of hypotheses generated in the first test session could give direction to the second.

Like Instrumental Enrichment, the LPAD materials are based on the conceptual framework of the cognitive map. Theoretically the examiner should be able to use the tests in a focused way to investigate a variety of cognitive functions which may be poorly developed or missing from the repertoire of the 'culturally deprived' individual (Feuerstein 1979). In practice there are a plethora of problems.

As Feuerstein's method of assessment and the teaching modules are built on the same model it should be possible to use LPAD to measure the outcome of pupils' exposure to IE. However, the LPAD is still a very intuitive procedure and whilst the ill-defined boundaries of the parameters of the cognitive map are of no hinderance to IE teaching (and may even be advantageous if it results in over-learning and reinformcement) they are not conducive to the precise categorization of an individual performance in terms of the cognitive map.

THE STATED AIMS OF LPAD ASSESSMENT

According to Feuerstein, Miller, Rand and Jensen (1981) tests developed in accordance with the model reveal data on the following:

"(a) The capacity of the examinee to grasp the principle underlying the initial problem and to solve it;

(b) The amount and nature of the investment required to teach the examinee the given principle;

(c) The extent to which the newly acquired principle is successfully applied in solving problems that become progressively more different from the initial task;

(d) The differential preference of the examinee for one or another of the various modalities of presentation of a given problem;

and

(e) The differential effects of training strategies offered to the examinee in the remediation of his/her functioning; these effects are measured by using the criteria of novelty-complexity, language of presentation and types of operation."
(Feuerstein et al. 1981B, p.205).

Indeed all of these can be accomplished but only in an intuitive sense. The Jerusalem group speak the language of precision and quantification in the literature but it is not the philosophy which they adhere to in practice. Their methodology does not permit it nor would they want it to (personal communication).

DOES LPAD MEET ITS CLAIMS? (A critique)

For all the above criteria quantitative information is needed to support qualitative impressions. What was the pupil's initial starting point? How much did he change? How much help was necessary to bring about this change? Was the amount of help reduced on subsequent items of similar or harder complexity? To claim that the level of functioning has been altered requires some form of measurement - from where to where? The following two quotes would suggest that LPAD was such an approach:

> "In order to assess and describe a change, we must have some means of conceptualizing the initial and end state as well as the nature of the change that occur."
> (Feuerstein et al 1981B, p.202).

> "The extent of modifiability and the amount of teaching investment necessary to bring about the change are assessed, respectively, by measuring the adolescent's capacity first to grasp and then to apply these new

> skills to a variety of tasks progressively more distant from that on which the principle was taught, and by measuring the amount of explanation and training investment required in order to produce the desired result." (Feuerstein 1979, p.92).

Although it is very easy to be satisfied that 'change' has occurred it is harder to record it using objective criteria. Not least because once you start helping a child to succeed he will now begin to solve items correctly, by himself, that he would not have been able to do before. The test-teach-test description of the test situation (Feuerstein et al 1981B) is also slightly misleading in that it implies a kind of mini pre- and post-test experiment. In actual fact this intervention is continuous throughout the test, so the 'modifiability' is ongoing. Without a baseline measure of unassisted performance it is impossible to disentangle the extent of the examiner's influence on the production of the pupils later responses: the subject may now be able to solve items correctly, without help, that were beyond his competence at the beginning of the test.

The Jerusalem group do not feel the need for a numerical evaluation of gain scores (personal communication). They have a child in front of them and feel it sufficient that they can see for themselves that his performance has improved. Only Feuerstein himself makes the concession that numbers have their place in research. The difficulty comes, however, when you try and describe a 'change' to someone who was not present at the test interview. The justification for using a learning potential approach, in preference over a conventional one, is that it says something about the capacity of the individual to <u>change</u>. LPAD therefore ought to be more specific about this aspect of performance. The same information is necessary even if one wishes to compare a pupil's performance with his <u>own</u> previous record.

The LPAD technique is designed to indicate a pupil's ability to profit from instruction; a transfer measure would thus be able to show the distance to which the learning has been carried over. To do this in a systematic way there needs to be information on the structure and complexity of the tasks, but no such item analysis has been undertaken for the regular members of the LPAD battery. If you want to make relative judgements concerning performance in the different modalities for instance, then you need to be sure that the difficulty levels of the tasks in these modalities are comparable. Nor are there any published details of administration, standardisation or scoring procedures and without these it is difficult to guarantee inter-tester reliability.

The scoring systems outlined in the unpublished manuals do not indicate change scores, the very thing that they are supposed to, and the profiles of individual case studies (Feuerstein 1979, Chapter 7), only report the scores in terms of percentages of correct responses: these indicate achievement and not change. The scoring systems for the LPAD tests, when used, basically follow the same pattern: correct with no help (maximum points), correct with minimal help, and those solved with examiner intervention (no points). The areas where the pupil is most likely to show 'modifiability' are on those items on which the examiner's help has been enlisted, but these items score no points!

A second major problem springs directly from the richness of the model: the examiner, who is already engaged in an intensive interaction with the examinee, is supposed to note down the pupil's responses in terms of the parameters of the cognitive map as well as the nature and amount of his or her own intervention. It must be remembered that the Phase parameter alone includes twenty seven sources of deficient cognitive functions, and the list is not exhaustive, (Feuerstein 1979). The problem of the 'looseness' of terminology of the model, and especially the Phase parameter, are a considerable handicap to an efficient recording procedure.

It would seem that there are more parameters than are actually necessary to describe performance. Given the ambiguous nature of some of these parameters (see the cognitive map, Part 2) it would be difficult, cumbersome, and probably not desirable, to gather information about a child's performance at each intersection of the parameters of the cognitive map. In point of fact the Israeli team do not code their recording schedules to cope with this information (Feuerstein et al. 1984). This is left to the inspired interpretation of the examiner after the testing event.

'MODIFIABILITY'

The concept of 'modifiability' is central to Feuerstein's theory of mediated learning yet neither the Jerusalem group nor the American workers make a direct or quantitative assessment of it. It is not built into the structure of the cognitive map but has to be deduced from the way a student's approach to the tasks changes over the course of the interview.

If a ten year old and a fourteen year old make the same gains on an LPAD test are they to be considered as equally modifiable, or does the younger child have the better prognosis? If it takes an examiner half a hour with a lot of intensive effort to get a pupil to understand a task whilst another, of the same age, only needs minimal assistance then what can we say about 'modifiability'? The results are the same (as both children finally gave the correct answer) but the interpretation of the success is surely different in the two cases.

There is some confusion as to how 'modifiability' is expressed. Does it really mean that the ability to change is self-perpetuating, as Feuerstein et al. (1981A) have suggested, or is it merely indicated by an individual's increase in absolute performance? The literature to date does not address questions about predictions drawn from 'modifiability' estimates. Who is more modifiable: a child whose initial starting point is low but who makes significant increments during the test, or one who is already performing optimally?

If Feuerstein is correct in assuming his intervention programme actually increases the autonomy and flexibility of the individual's cognitive processes then 'modifiability' can be understood in terms of the Piagetian notion of adaptation. If the power of a child's assimilatory schemata are increased as a result of intervention, then undoubtedly he will be better adapted to reality. Thus in one sense the child's 'modifiability' has increased. If, on the other hand, intervention has caused the child to accommodate to reality, thereby increasing the power of his assimilatory schemata, then 'modifiability' in another sense might be expected to gradually diminish even though he has become better adapted. In other words, if IE remediates a child's cognitive deficiencies then the parallel improvements in processing efficiency might lead to a closure of the gap between what a child does do and what he can do. Changes in 'modifiability' of pupils exposed to IE, as measured by LPAD, will be looked at as one aspect of the present study.

Earlier in this section the claims for LPAD were quoted, Feuerstein (1979, Chapter 7) and his co-workers used a research methodology to investigate some of these claims. They looked at the effect of different teaching strategies on subjects' ability to solve problems in the verbal and figural modalities. This is a step in the right direction, if the model is ever to be tested, but it is not a complete solution. Firstly, the approach does not conform to the clinical one outlined in the previous chapters of their book. Since the information generated in a regular LPAD session does not fit this more analytical framework, it cannot be used to answer the same questions. Secondly, the research testing procedure provides no information on the cognitive impairments of the individuals in their sample, but the strength of LPAD testing is that it can do so.

In the same book Feuerstein outlines a number of areas which in 1979 needed important elaborations and development. These include:

> " (1) the establishment of a baseline, the creation of norms for evaluating modifiability, and an Index of Modifiability; (2) the expansion of the battery of individualised and group instruments; (3) the testing of a broader segment of the population by LPAD procedures; (4) the development of techniques for assessing potential modifiability in areas of specific learning disabilities; (5) the expansion of methods of identifying individual preferential language and modalities of learning; and (6) a clarification of the nonintellective factors critical to specific and individual levels of modifiability."
>
> (Feuerstein 1979, p.321)

A lot remains to be resolved and published!

The above outline of some of the problems connected with LPAD assessment and the model on which it is based is not intended to be destructive, rather, it reflects a genuine concern for the factors which inhibit the LPAD practice from becoming a more acceptable and widely used technique. In Chapter 2 some of the solutions adopted in this study will be outlined. So far Instrumental Enrichment has captured most of the research interest. Apart from the present investigation, which follows, there has been little or no work on the 'molecular' aspects of LPAD testing, (Consultation with Feuerstein in

March 1983 and February 1984). However, the beauty of LPAD is twofold: it is a humane and optimistic approach to the assessment of low achievers and it provides a description of the processes which underlie successful and unsuccessful performance, with clear implications for remedial action.

CHAPTER 2.

OBTAINING QUANTITATIVE MEASURES THROUGH THE LPAD TECHNIQUE

As Feuerstein's method for the assessment of 'Learning Potential' and his IE teaching modules share the same cognitive model it should, in theory, be possible to monitor the success of the latter using his own dynamic assessment technique. The LPAD can be used to provide information on a pupil's use of cognitive functions - from the Phase parameter of the cognitive map - and on his 'modifiability'; that is, his potential for change as a result of adult intervention. Neither of these aspects of performance are covered by the pre- post-test battery of Piagetian, psychometric and achievement tests, outlined in Chapter 3, which are used in this study for evaluating the effects of IE training.

However, there are a number of problems concerning the use of LPAD tests in their present form. This chapter outlines the problems encountered in using the LPAD method and provides a discussion of the final strategy for investigation that has been adopted.

EXPERIENCE WITH LPAD TESTING

In order to use LPAD as one way of monitoring the effects of IE it had first to be sharpened as a clinical tool. To this end work has been done on standardising the format, the administration, scoring and recording. However, before this was possible, it was necessary to gain first hand experience of the dynamic principles which sets LPAD apart from the more conventional methods of testing. Due to the lack of published details concerning <u>all</u> aspects of LPAD testing, it took nearly a year to acquire the art. It took longer to arrive at a procedure which was reproducible and capable of yielding quantitative as well as qualitative results.

Firstly my supervisor and I had to become familiar with this mode of testing. A number of testing sessions were conducted between February 1982 and the start of this investigation. Four different schools were visited: the remedial department of a London girls' comprehensive, an ESN(M) school in Buckinghamshire, the remedial department of a mixed comprehensive in Dorset and a second girls' comprehensive in London. During each batch of testing, variations in administration and recording procedures were examined for their suitability for adoption in the final approach. Experience of shortcomings of one method influenced the modifications that were introduced on the next occasion.

Prior to the examination of the children participating in this study, 29 children, aged between 11 and 14 1/2, were tested. Forty test sessions in all were held (some children were seen more than once). I administered a total of 77 LPAD tests as shown in Table 4.

TABLE 4: EXPERIENCE WITH THE LPAD

Tests	No.of administrations
LPAD Variations 1	17
Organization of Dots	15
Raven's Progressive Matrices	13
Plateaux	9
Representational Stencil Design Test (RSDT)	8
Rey Complex figure	5
Numerical Progressions	4
Associated Picture Recall	4
Verbal Analogies	2
	77

This was very much a period for familiarising ourselves with the tests and discovering what each could tell us, that is which were the most useful in pinpointing particular cognitive 'deficiences' and the advantages and limitations of using each.

In March 1983 I was invited to spend one month at the Hadassah-Wizo-Canada Research Institute to meet Professor Feuerstein and his co workers. This provided an invaluable opportunity to discuss our common aim of recording changes in terms of the parameters of the cognitive map and the problems faced in doing so.

The principal aim of the visit was to confirm that the necessary LPAD testing skills had been acquired. I was able to watch a number of their teaching videos as well as being present at several actual testing sessions and some lectures given by Feuerstein at the Bar Ilan University. Whilst I was there meetings were held at which various LPAD workers described their thoughts on the 'dimensions of modifiability' which should be considered when constructing a profile of pupil performance. However, much of the discussion revolved around non-cognitive aspects of change. Group meetings were also arranged to establish inter-tester reliability. Selected tapes were shown of performances, including both examiner and pupil errors, and were discussed in order to arrive at a consensus of interpretation.

The second major reason for the visit was to discuss the scope of this proposal; what would be feasible to attempt and which approach should be adopted. There was some hostility to the notion of using LPAD as a yardstick for IE. This was partly because it would necessarily involve the introduction of a degree of standardisation and quantification that is alien to some LPAD workers. Except to Feuerstein himself, words like standardisation and quantification are not part of the acceptable vocabulary. As a partial solution, Feuerstein and I arrived at a means of monitoring examiner intervention and the 'mediational-hierarchy' was constructed as a result.

Some of the questions asked remained unanswered and others concerning research hypotheses about the effects of IE await experimental investigation. Nevertheless it was a great privilege and a useful experience to see others applying the art of LPAD testing and to witness first hand some of their more recent innovations.

CHOICE OF TESTS.

Out of all the LPAD tests it was decided that the Raven's matrices, with the LPAD Variations, and the Representational Stencil Design tests should be given in the final study. A complete range of LPAD tasks would have been desirable but because of the lack of standardisation of the battery it was thought prudent to concentrate on a few of the tests and develop them. Furthermore, the LPAD tests are extremely time consuming: each individually administered test can last between 3/4 hour and an hour and a half. As these children already faced other pre- and post-test measures, in addition to their regular school tests, the complete battery would undoubtedly have resulted in test fatigue.

The tests were chosen for a number of reasons. They had to allow for the possibility of a wide range of examiner interventions so that there was scope for cognitive improvement both at the initial time of testing and at the re-test one year later. Some of the tests in the LPAD battery have limited opportunities for the examiner to offer mediation and for the subject to demonstrate 'modifiability'. The tests must also allow for the expression of 'deficient' cognitive functions. The LPAD variations, RSDT and Organisation of Dots tests are frequently used in LPAD assessment because of their ability to highlight cognitive problems. Of these, the latter was rejected because it was to be taught as an instrument to the IE class. This would have given an unfair advantage to the experimental group.

Professor Feuerstein particularly requested that Raven's matrices be included in this study to challenge the contention of Raven (1965), and later Jensen (1969), that tasks representing higher order thinking are largely inaccessible to high-grade 'defectives'. Although Feuerstein admits that these level II type activities are not part of the immediate repertoire of these individuals, they can with training grasp and apply the more complex operations that the matrix problems demand.

Feuerstein argues that despite the progressive nature of the tasks (Raven's matrices) learning is not necessarily elicited in the culturally deprived child precisely because of his inefficiency in storing and utilising previous experience. The reader is reminded that Feuerstein's definition of cultural deprivation is a low level of modifiability by direct exposure (caused by a lack of mediated learning experience). Jensen (1969, 1970) postulates that level I and II types of intelligence are largely innate, however, if it turns out that level II activities can be induced then this must cast doubt on his bi-level theory.

In order to indicate that subjects answering Jensen's description of level I intelligence, that is having IQ's between 60 and 70, do have a capacity for high-level thinking, Feuerstein (1979) has trained retarded adolescents in the relevant metacognitive strategies for success on Raven's matrices.

This study is a more stringent test of Feuerstein's claim. Mediation is not provided on Raven's matrices but on the LPAD Variations, which are based on the matrices, and the transfer of acquired skills is established by giving Raven's as an unassisted mini pre- and post-test within the test session. Gains can then be described in terms of an increase in mental age and percentile rank using the Raven test norms. In addition, a second indicator of 'modifiability' is obtained by measuring the amount of intervention offered to the subject during the LPAD phase of the test interview.

The Representational Stencil Design Test (RSDT) provides an insight into an examinee's ability to develop internalised problem solving behaviour. The pupil is given a chart of brightly coloured stencils and a design that he has to copy using the stencils from the chart. The stencils have to be mentally superimposed on top of each other in a given order for the design to be identical. The tasks can be simple two stage designs but as many as seven may be involved (see Figure 7).

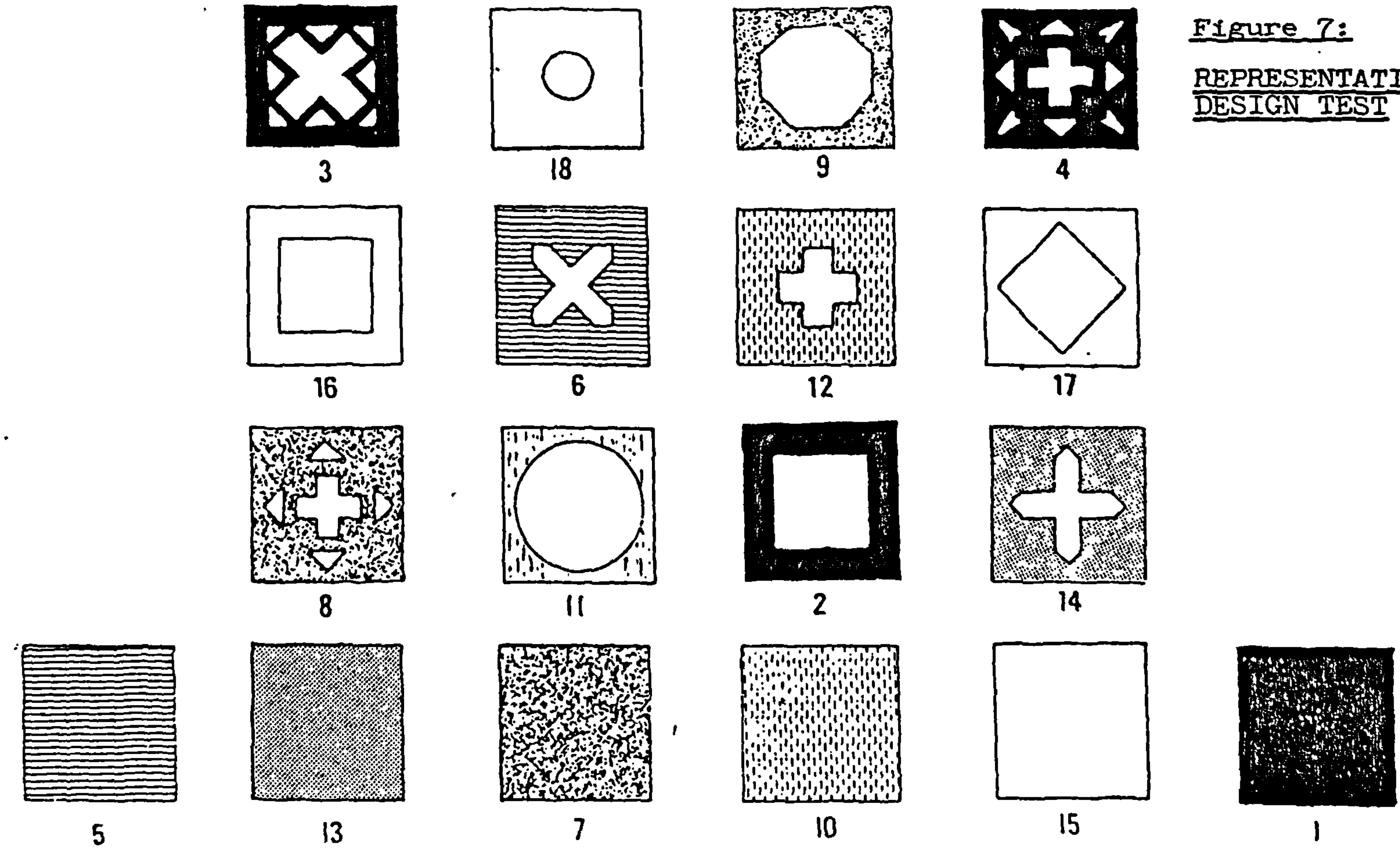
The test is based on Grace Arthur's (1930) test although it has been modified. In the original test the subjects were at liberty to manipulate cut-out stencils, and the only criterion for success was the production of the correct solution within a time limit of four minutes. No attention was paid to the number. or type of inappropriately handled stencils and no sanctions were applied for the different degrees of error. By removing the possibility of manipulating the stencils physically Feuerstein has made the task a representational one: the examinee has to represent to himself the outcome of his mental acts and update the representation to arrive at the final solution. Decisions about the correctness of a solution must be made by comparing a mental image with the actual design. These tasks are not considered easy even for a 'normal' adult, especially when a number of stencils are involved.

Feuerstein believes that too much emphasis on the use of the motor modality of search may actually inhibit reflective thought processes in the culturally deprived child. These children gain only a limited amount of information from trial and error exposure because of their deficient cognitive functioning and lack of active learning

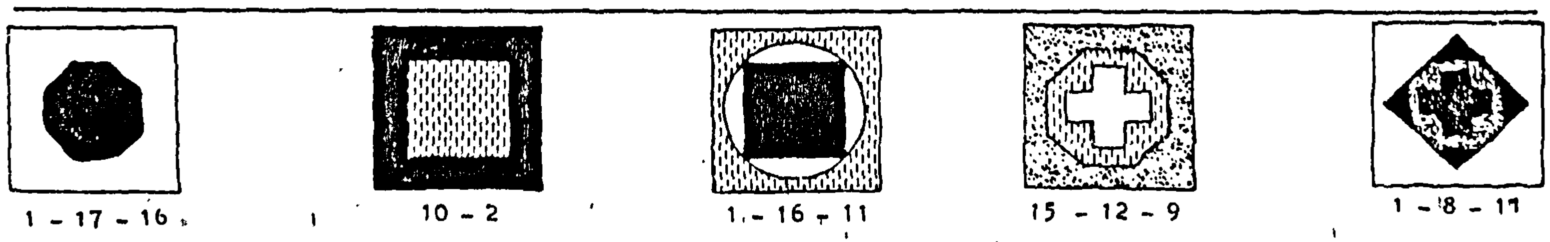
Figure 7:

REPRESENTATIONAL STENCIL DESIGN TEST

Stencils Used to Construct Designs.



Some Sample Designs



processes.

A drawback of using this test is the lack of information on test reliability. However, it can provide a rich source of qualitative information on the Phase parameter because the error patterns of pupils are quite well established. For example, it is common for there to be confusion when discriminating between the form and the colour of the stencil designs; the child often perceives the colours of the background and stencil as reversed. This is a clear cut demonstration of a 'blurred and sweeping perception'.

KEY ASPECTS OF THE MODEL.

Even when working with only a few tests in the LPAD battery, problems occur when using them diagnostically to interpret an individual's performance in terms of the cognitive map. In some ways the model which Feuerstein presents is too rich. There are many more parameters than are actually necessary to describe performance (refer to Chapter 1, Part 2). A degree of selectivity is therefore required in choosing the focus for assessment. Until the model fully emerges from its final stages of development, a certain amount of liberty on the part of the researcher is permissible as to which aspects of the model are included in the evaluation and how they are implemented in the study.

In this case, the Phase, Operation and Modality parameters were considered in that order of importance. Of the four parameters omitted, the Content and Complexity parameters are already determined by the test materials and the levels of Abstraction and Efficiency are considered to be extremely vague concepts. Apart from being difficult to pinpoint, use of them would only bring a limited amount of additional information to the assessment.

The modality of presentation or response does not vary much in practice since most interactions between the examiner and pupil are verbal. Nevertheless it is possible for a child to have a preferred channel of communication through which he performs optimally. In a comprehensive interview this should be considered.

One of the primary goals of Instrumental Enrichment is to provide the learner with certain basic concepts, skills and operations. Interpretation of performance in terms of the LPAD model must make provision for investigating this parameter. Unfortunately Feuerstein enjoys a very liberal interpretation of the word operation (see Chapter 1, Part 2). Furthermore, this is one area in which there are continually new additions to the list so that it would be impossible to cover it in a systematic way. However, for the purposes of evaluating IE, a Piagetian test battery was administered, pre- and post-test, to gain an independent measure of improvements in the level of operational functioning (Chapter 3). This provided a more limited assessment than Feuerstein would have liked but the results are more precise.

The Phase parameter is the most interesting and unique aspect of Feuerstein's model. It characterises a range of cognitive functions that are poorly developed or inefficiently used by the population which he describes as culturally deprived. Attempting to measure these 'deficiencies' by LPAD testing provides some internal validity for the model.

USING THE COGNITIVE MODEL: PHASE.

Two things quickly become apparent whilst working with the list of deficient functions. Firstly, there are too many to keep track of in a testing session and, secondly, they may overlap to a degree which makes it difficult to observe them independently. For IE this is relatively unimportant as there is no need to maintain strict boundaries between the teaching of one cognitive function or another.

For assessment purposes, however, the same degree of flexibility or overlap is not permissible.

The Examiner needs a check-list of observable 'deficiencies' to guide his observations during the test. These 'deficiencies' must have recognisable behavioural correlates which must be meaningful in the context of a particular test. For instance, in the LPAD Variations a student has difficulty with problem definition if he experiences no disequilibrium, that is he does not feel the need to complete the matrix by choosing one of the given alternatives. For RSDT the same deficiency is observed if the student is unable to view the stencils as cut-outs and cannot therefore imagine superimposing them on top of each other.

A list of characteristic features of impaired performance was drawn up for the two LPAD tests that featured in this study, and brief descriptions of the criteria used to indicate the presence of a deficiency are outlined in Table 5. There are a finite number of possible pupil errors and these have been incorporated into the descriptors of impaired functioning. This includes eight major categories of impairment and ten others which are related to these but are behaviourally distinguishable. (Not all the deficiencies are observed on all tests). The only other change to Feuerstein's original list of deficiencies (see Table 1) is the introduction of a sub-category called insufficient evidence. This followed the observation that many children are not necessarily illogical when answering, they merely fail to substantiate their arguments with all the information that is available to them.

ISOLATING THE DEFICIENCES.

There are several ways to get at the same information from a pupil so that standardisation does not imply rigidity. For instance

Table 5 : Cognitive deficiencies with behavioural correlates for the LPAD Variations and RSDT

DEFICIENCIES	LPAD VARIATIONS	RSDT
*LABELS	Inappropriate descriptions of the shapes.	Imprecise names for the stencils
PROBLEM DEFINITION	Experiencing no disequilibrium. (Need to complete matrix).	Unable to view stencils as cut-outs.
RELEVANT CUES	'Matching' answer to piece in the matrix.	Confusing colour with form & stencil no. with Q. no.
IMPULSIVITY	Answering after insufficient processing.	Answering after insufficient processing.
BLURRED PERCEPTION		Confusing the base colour with 1st stencil
PRECISION AND ACCURACY		1 incorrect stencil, 1 added, 1 missing
ATTENTION TO SEQUENCE		Stencils given in the wrong order.
TRIAL AND ERROR	No systematic search.	Random sampling of stencils. No analysis.
BLOCKING	SS not receptive to information.	SS not receptive to information.
2 SOURCES OF INFORMATION	Inability to grasp and apply relationships between matrix pairs.	
HYPOTHETICAL THINKING	SS unable to predict the matrix solution.	Limited grasp of rules of construction.
INTERIORIZATION	Misunderstand aid, repeat same error.	Misunderstand aid, repeat same error.
EPISODIC GRASP OF REALITY	Extreme depend nce on examiner for solution. Limited memory span.	Extreme dependance on examiner for solution. Limited memory span.
VISUAL TRANSPORT		Difficulty retaining mental image.
LOGICAL EVIDENCE	Inappropriate sources of information.	
EGOCENTRIC COMMUNICATION	SS does not differentiate self from examiner.	
INSUFFICIENT EVIDENCE	Uses only 1 feature of the answer.	
POOR COMMUNICATION	Poorly expressed response.	

* Those deficiencies which are underlined form the major categories.

to know why one solution is worse than another or why an alternative is not correct, pre-supposes the same knowledge, that is the answer to the question, "why is this right ?" In the case of the matrices problems the use of 'two sources of information' is essential for finding solutions. The Piagetians have a similar approach; they cover a question from a number of different angles yet they are still able to reach a consensus as to the level of operational functioning without losing the essential uniqueness of the interactive process.

Very often impulsivity is the reason behind an incorrect response; by pointing this out the subject is provided with an opportunity to demonstrate his true capabilities. The following dialogue conducted between myself and Nicole, a 12 year old girl from a London comprehensive school, concerns the Representational Stencil Design Test (refer to Figure 7). The first question required her to mentally copy a two stencil design by giving me (the examiner) the corresponding stencils in the correct order. In this case the yellow of the base is visible through the large circle that is cut out of the green stencil on top (using stencils *13 and *11). Nicole had a number of difficulties, here are a few examples:

Question 1

E: Right, what I want you to do now is to tell me the stencils you will need to make these shapes, (points) - these are called stencils, these cut out shapes. In the order that you need them to make this design. Do you understand ?

N: No.

E: All right, well if I put these on top of each other,

(* refers to stencil numbers)

which ones will I need to produce that shape ? (Examiner indicates that they are made from the cut-out stencils).

N: That one, you use *17. (A white diamond).
(Problem definition)

E: For no. 1 ? (said as check on impulsivity).

N: For no. 1 if you put it on that one then it will be just big enough. (Mixing up the numbers underneath the stencils with those underneath the questions). I dunno.
(use of relevant cues)

E: Well you have got to imagine that these are put on top of one another. I have got to get this colour (yellow) underneath. (Focus on the components of no.1).

N: What you mean like yellow and green ?

E: What colour is on the bottom ?

N: The bottom, green.
(Blurred and sweeping perception)

E: Green isn't on the bottom, what colour is in the middle ?

N: Yellow.

E: Right, so what happens is that we have got one layer on top of the other to produce this shape. We have to look at what is in the middle. WHAT IS IN THE MIDDLE IS ALWAYS ON THE BOTTOM, okay. So if it is yellow is the middle we see a yellow solid, *13, then we have to get this shape on top. (A green stencil with a large circle cut out).

N: On top ?

E: Uh huh, which one will give us that ?

N: *10 (solid green)

(Attention to sequence - caused by impulsivity.)

E: *10 ?

N: No, number.. 11.

E: *11. So which ones am I going to need ?

N: You're going to need *11 and *1 to put on top of .. to make a round circle again. (Uses 1 from question 1 rather than stencil no's.)

(Use of relevant cues. Hypothetical thinking).

E: This is *1 (point to solid black) forget these numbers under here (question numbers). These just tell you the number of the problem that we are working on.

N: Right.

E: Well, which stencils will I need to give this colour here (yellow)

N: *11. (She has given the green stencil)

(Blurred and sweeping perception).

E: Well this would give us the green outside, but what colour is going to give us this ? (Points)

N: Yellow, *13.

E: So which am I going to need, which will be on the bottom?

N: Yellow.

E: *13 and then ..

N: On top *11.

E: Great, okay so you do understand what you have got to do now. Same for this one, (question 2)

It does not usually take so much intense intervention for the subject to reach a solution on the easiest items. Her extreme dependence on the examiner for the production of the solution is indicative of an episodic grasp of reality. Nicole had difficulty using the relevant cues to help her and later in the same interview she gave evidence of not fully understanding the problem by wanting to cut the shapes out of the solids. The examiner should be extremely careful in the way feedback is provided so that any enthusiasm the child does have is not endangered and hopefully to foster this attitude if it does not exist. In this interview it was necessary to do a lot of talking in order to ensure Nicole's concentration.

When blurred perception is the result of impulsivity then the interaction is more likely to go as follows.

(This is taken from the same interview, she had been asked what would happen if *18 was put on top of *9 - *18 is a white stencil with a small circle cut out, *9 is a red stencil with a large octagon cut out).

E: What would happen if I put *18 on top of *9?

N: You get a circle with a red outline with a shape like a 50 pence piece.

E: If I put *18 on stop of *9 ?

N: Oh, you'll just get a white dot with a white round it.

E: Good. So I'll just see this ? (points to *18). This here, (points to gap), is cut out.

N: Yeh, and you'd just see the white rounding.

This conversation had taken place prior to the previous one so the cognitive functions do not always operate in a regular or predictable manner. Here she was free of the demands of defining the task for herself and notice how much easier it was to correct the oversight.

RECORDING THE DEFICIENCIES.

The lack of published details of the administration, scoring and recording of LPAD tests meant that many false starts were made. Developing a suitable recording schedule has been a priority for the fieldwork of this study. (A few examples of unstructured reports of LPAD testing sessions can be found in Appendix 2A). The examiner needs a system for coding the details of the pupil's performance and his own contributions in the production of the solutions. An intuitive approach to assessment, as favoured by Feuerstein's people, can, if one is not careful, lead to a biased overview of the performance: if only the most intersting or distinctive responses are recorded and not the average ones. In the latter case, a pupil's 'modifiability' can only be discussed in terms of anecdotal instances of improvement. The Phase parameter has featured extensively in the numerous recording schedules that have been developed. The changes from one schedule to the next were concerned mainly with which categories of deficiency should or should not be included.

In April 1982 three video recordings were made of my supervisor and I conducting LPAD test sessions. The tapes were later played to examine the consistency and efficiency with which the various schedules could be used. As a result we arrived at a list of deficiencies which had behavioural correlates, (refer back to Table 5). By using these ' deficiencies' as guidelines for observation, profiles of positive and negative response patterns could be drawn up for each pupil.

Figure 8 illustrates how the recording schedule can be used. There are many possible combinations of response. One the first question (A) the pupil knows that the question requires him to fill in

FIGURE 8 : EXAMPLES OF RESPONSES TO THE LPAD VARIATIONS

	(A)	(B)	(C)	(D)
LABELS	A	▲	A	▲
PROBLEM DEFINITION	▲	-	-	-
RELEVANT CUES	✓	-	-	-
IMPULSIVITY	-	ch	-	✓
BLOCKING	▲			
TRIAL AND ERROR	▲		✓	
2 SOURCES OF INFORMATION	✓	✓	✓	▲
HYPOTHETICAL THINKING			✓	
INTERIORIZATION			✓	
EPISODIC GRASP OF REALITY				
LOGIC	▲	E	E	▲
EGOCENTRIC COMMUNICATION	▲	▲	▲	▲
INSUFFICIENT EVIDENCE	✓	E	E	✓
LANGUAGE	✓	E	E	A
MEDIATION LEVEL	7	6	8	3

▲ indicates good / correct response
✓ indicates a deficient cognitive function
E indicates the examiner describes the solution
A indicates an adequate verbal response
ch indicates the subject 'checked' his own impulsivity

the matrix with one of the alternatives; hence from here on his understanding of the problem need not be recorded unless he subsequently makes a mistake. However, through questioning, it is revealed that he does not understand how to make that choice. The most common error is for the pupil to try to match his answer to a piece that already exists in the matrix, without appreciating that a transformation has occured. He requires some teaching in the use of two sources of information in order to solve the problem and therefore the error was not one of oversight (impulsivity).

The mediation level refers to the amount of assistance, on a ten point scale, offered by the examiner in the production of the solution (in accordance with the mediational-hierarchy, to be discussed). A high mediation score indicates that the pupil had difficulty with the task. On question (A) the pupil received a mediation score of seven, however, he was able to point to the appropriate sources of logic for his answer, although he only provided a partial solution, and his use of descriptive language was inadequate.

If the subject's response has been poor then examiner clarification can be assumed. An 'E' is only recorded when the examiner has been responsible for describing the complete solution.

On the second question (B) he again needed the strategies pointing out to him (mediation level 6), although he was able to check his own impulsive response. However, he was not able to provide any justification at all for his answer and it was left to the examiner to explain. On question (C) he was asked to predict the solution, as a test of hypothetical thinking ability, but he could not do so. Again, this was not due to an impulsive tendency, because he had still to grasp how to use two sources of information and needed further instruction in doing so. The instruction was not immediately understood because he repeated his errors (interiorization). The notion that the mistake was not just one of oversight is reinforced when he lapses into trial and error behaviour in a desperate attempt to find the answer. Further training was necessary. Mediations up to level 8 were given but the pupil was still dependent on the examiner for the communication of the response.

Lastly, on problem (D) the pupil makes a minor impulsive error which is easily corrected (level 3). This time he points to the right kinds of information although he is still unable to provide a complete rationale.

A response chart such as that shown in Figure 8 can be constructed for the entire LPAD Variations (or RSDT) and provides a tangible record of performance from which comparisons can be made.

THE NEED FOR A STANDARDISED PROCEDURE.

Conventional psychometric techniques have been criticised by Feuerstein (1979) for failing to fulfil the essential task of assessing the culturally deprived child's potential for change: their very design disallows the possibility of learning because it excludes or provides only very limited training. Consequently the students are left ill-prepared for the harder items. Feuerstein's techniques specifically address themselves to this problem, yet they provide no direct measure of the 'modifiability' they seek to describe. If 'modifiability' is to estimated then there needs to be a more direct approach to determine the initial and end points of performance and the ease with which the change was brought about.

Feuerstein and his co workers have a free-style approach to the assessment of potential. That is, they go off on whichever tangents present themselves for investigation in the testing session without ensuring that the same ground has been covered for each child. The results of such investigations may prove to be extremely interesting but comparisons between different individuals (or the same individual at different points in time) cannot easily be made.

There are two further problems with LPAD as a method for the assessment of potential for change. Firstly, as the examiner actively assists the pupil during the test, a means of calibrating the amount of assistance offered is needed in order to differentiate between the achievements of different pupils. Data on the frequency of help being offered by itself is not sufficient to indicate the nature of the interaction, because some interventions are more helpful than others in prompting the correct solution. The second problem is that without a baseline estimate of <u>unassisted</u> performance, it is impossible to determine the extent of the change in performance as a result of mediation. This is because once the examiner has intervened, the child may be able to solve items correctly which previously were beyond his competence. Both of these problems receive attention in this study.

THE MEDIATIONAL-HIERARCHY.

The mediational-hierarchy consists of a sequence of examiner interventions graded on a scale of 1 to 10. If a child corrects his error after the examiner has merely asked him to "Look again", then it is far less significant in terms of his cognitive impairments than if he were told for instance how to apply the relationship in a two-way matrix problem. The scale reflects both the qualitative and quantitative aspects of the examiner's intervention. The original hierarchy, drawn up with the cooperation of Professor Feuerstein, has been modified because in practice the interventions tend to bunch around the higher levels. The revised sequence provides the opportunity for the brighter pupils to succeed at lower levels of mediation.

The principle of the hierarchy remains the same, namely that a pupil demonstrates his capacity for 'modifiability' by the amount of independence from the examiner he exhibits in his response. The ease of correction of the deficient cognitive function is the key to our understanding of estimates of 'modifiability': How much help was necessary for this question to be solved ? Was less help offered on the next question, or on a different occasion ?

The hierarchy can be adapted to suit a particular LPAD test, or in other words, the levels of help can be written in the language that the examiner is likely to use on that test when overcoming specific difficulties. Ten stages of help were thought sufficient to discriminate between the various levels of perfomance. Examples of the hierarchy for the LPAD Variations and RSDT are shown in Figures 9 and 10.

It must be stated that any interventions which merely encourange the child do not count against him, nor do interventions which call for greater precision in the use of language because this was felt to discriminate against certain populations. Since the intention is to examine reasoning ability, only those interactions that have a direct bearing on this aspect have been included in the structure of the hierarchy.

Examples of some of the levels of intervention in practice are illustrated from the transcript of Nicole on the Representational Stencil Design Test:

E: Lastly, what would I get if I put *18 on top of *9 ?

N: You'll get a circle with a red outline with a shape like a 50 pence piece.

E: If I put *18 on top of *9 ?

N: Oh, you'll get a white dot with white round it.

Figure 9: Mediational-Hierarchy for the LPAD Variations

1. ASK THE SUBJECT TO DO IT AGAIN
   * Look closely, are you sure, be careful and so on (imply a need for more precise data gathering).

2. MOTOR FOCUSING
   Tapping with a pencil,for example the pieces in a matrix, to indicate that the pattern has to be followed from left to right.

3. REMINDER TO USE PREVIOUSLY LEARNT STRATEGY
   Remember to look from left to right to see what stays the same and what changes (usually as a response to blocking).

4. LEAD THE EYES, RESTRICT THE FIELD
   Focus on a specific aspect. What about the colour? Does it need to be a square? and so on. So it will match this one? (point to matrix part).

5. PROVIDE / ELICIT GOVERNING RULE
   If the subject is stuck or does not understand what the relevant cues are, tell him he needs to look from left to right (at the top of the matrix) and decide what has stayed the same and what has changed. Whatever happens on the top row also happens on the bottom.

6. EXAMINER FOCUSES THE SEARCH
   By providing the top row analogy for the subject but only in terms of the shape and pattern. For example, the shape has changed but the pattern has not. The subject must apply this to the second row.

7. FURTHER FOCUSING
   Point out the correct or incorrect aspect. You said we needed a ...No we have not lost the circle, we have gained the diamond. What would happen if we add a diamond to this? If we turn the star round by the same amount.... and so on.

8. EXAMINER REDUCES THE MEMORY LOAD
   If the subject has not understood how to use two sources of information from mediation 6 then go through it again step by step. What shape do we need? What will it look like inside? Summarise, so it will be the same colour but a different shape and turned on its side and so on.

9. EXAMINER DESCRIBES THE EXPECTED SOLUTION
   Go through the transformation again and explain the origin of the piece to the subject. Give the appropriate labels: so we are looking for a black diamond turned on its side.

10. GIVE THE SOLUTION
    It is no. ..isn't it ? because we said we needed a ... Explain why the answer is correct.

* These are just examples of the levels of help offered. The list is not exhaustive.

Figure 10: Mediational-Hierarchy for RSDT

1. ASK THE SUBJECT TO DO IT AGAIN
Are you sure? and so on (infer a need for greater precision).

2. MOTOR FOCUSING
Tapping the page of stencils, you mean here,here, and here ?

3. REMINDER TO USE PREVIOUSLY LEARNT STRATEGY
How did we decide what comes next?How did we decide on the order? (usually a response to blocking).

4. LEAD THE EYES, RESTRICT THE FIELD
In what order do the colours arise? What is on the bottom ? How many colours? Use the subject's own error: 1 added, 1 missing, 1 in the wrong place and so on (usually a response to an impulsive decision).

5. PROVIDE / ELICIT GOVERNING RULE
The middle of the design is always at the bottom. The bottom of the design always needs a solid stencil. If you put a solid in the middle of a design it will cover those stencils underneath it. Order is not irreversible. Two stencils of the same colour will merge together. If you put a stencil on with a small aperture then it will mask most of the design underneath. Work by a process of elimination, if it is not this one then it must be ...

6. EXAMINER FOCUSES SEARCH
If the middle of the design is always on the bottom, then what do we need here? If the bottom one is always a solid then which one will it be? Relate the principles to the question the subject is working on but let him solve the task.

7. FURTHER FOCUSING
Fine detail search. How did this get here? Where do the triangles come from? Explain about the width of the apertures: that is too big/small, it would cover/show ... Which stencil would let us see that one (point) through the hole? Put two stencils together to make the shape.

8. EXAMINER REDUCES THE MEMORY LOAD
Take the design stencil by stencil: what is on the bottom? What comes next? Next?..What shape is cut out of the white that lets us see the ... So we need blue, red, yellow,white, good.. which ones? If need be trace the stencil for the subject but he must find the answer for himself.

9. EXAMINER DESCRIBES THE EXPECTED SOLUTION
From the bottom upwards: on the bottom is red, then we see white with a small circle cut out (point),then on top of that there is a blue with a cross cut out and so on. Ask the subject to find them.

10. GIVE THE SOLUTION
Provide the solution and explain it step by step.

E: Good, so I would just see this (points to *18 - a white stencil with a small circle missing from the centre, masking the red stencil underneath it).

N: Yeh, you would just see the white rounding.

Very little effort was needed to change her performance. The question was merely repeated with the implicit suggestion that she had better look more closely for her to realise her mistake. This minimum amount of help would rank level 1 on the scale.

In the next excerpt, (level 4) , Nicole's attention was specifically drawn to the fact that the order of the stencils is important - if a solid is placed on top of a cut-out then it automatically hides whatever is beneath it. If this rule had needed to be spelled out, then the intervention would have moved further up the hierarchy.

N: Q.6.... white... no blue on the bottom and white on the top, *5.. is and on the top is *15.

E: *15 on the top and *5 on the bottom ? ...If I put *15 on top of *5 what would happen ?

N: Oh no, it would be *18 on the top of *5, wait a minute, no..yes..it would be *18 on top of *5.

E: So now *5 is on the bottom and *18 is on the top.

The last extract shows complete dependence on the examiner. Nicole had already been told to copy the shape using the stencils available, she was also asked which stencils were possibilities and finally she was asked to trace on top of question 20 where the stencils would go, but the answer still eluded her:

E: This is the hardest on the page, now if I put *17 on top of here (Q.20) where would the lines go ? Point to me where they would go.

N: (Traces on the stencil but it doesn't help)

E: So I have got part of the answer then havn't I, and what about if I put *16 on where would the lines go ?
(This is the other part of the answer but it did not produce any recognition - so far level 8).

N: (hesitates).. It would really be exact but it is not the shape because on that it goes like that and that and you would see white gaps.

E: That's right, but what about if I put both of them on ?

N: Yeh, yeh .. you can't put both of them on because *17 is lopsided and *16 is like a square so that you would get it like a star.

E: If I put *16 on here ?..

N: You get it in a square.. I don't know.. oh dear !

E: Don't give up you are doing fine, it is very difficult this one.

N: You would get a kind of shape like a star but very small.. I don't know.

E: If I put that shape (*16) on here it will go like this- (E traces it).

N: But it still wont be the same.

E: Why ? because you think these bits will still be white. (repeated intervention).......

E: If I put *16 and *17 together then I would get a line here, here, here, here, here, here, here, here. (E. illustrates).

The examiner gives Nicole progressively more and more help to solve the problem (as each level fails to provoke the correct response), until eventually the solution is explained to her. A maximum mediation score of 10 is given.

BASELINE MEASURES.

The Israelis argue that taking a baseline measure is against the spirit of the LPAD method and prefer to leave the estimates of 'modifiability' to the intuitive judgement of the examiner. The demands on researchers however are different. One factor of constant concern throughout the groundwork for this study was the lack of normative data which would enable one to make a valid comparison between one pupil and another, or even with himself at a later point in time. It might be obvious to the examiner that the child's performance has improved, but by how much ? Without a baseline measure of the performance, prior to the mediation, it is impossible to assess the amount by which he profited from the experience.

Further, if a ten year old and a fourteen year old make the same gains on a test, are they to be considered equally modifiable ? It would be extremely useful to be able to measure a given performance against those of children of the same age. Unfortunately there is no normative data for the LPAD tests.

MEASURING MODIFIABILITY (PRESENT STUDY)

In this study external norms have been adopted for measuring an individual's potential for change. The Raven's Standard Matrices, SPM, (1958) have been used with the LPAD Variations to give the examiner some idea of the improvements in performance an individual may make as a result of mediation (adult intervention), on the LPAD Variations.

Part of the spirit of LPAD testing is to encourage the subject to believe in his or her own powers of thinking and action. It is therefore not desirable to use SPM as an ordinary psychometric test, where the subject is forced to see how incompetent he is. In the test manuals from Jerusalem, Raven's matrices are given in the spirit of LPAD testing (assistance is available to the subject). When the subject begins to fail they switch to the LPAD Variations and this provides further opportunities for mediation. The problem is that the use of the matrices has not been made quantitative in the Jerusalem methodology: the obtained scores have not been related to the Raven's test norms, nor has an ambiguous 'cut-off' procedure been defined. Michael Shayer has developed a procedure whereby Raven's matrices can be given in its psychometric form to estimate a subject's total score, without it being necessary to attempt all the items. This methodology means that the Raven's norms can be used to quantify pupil performance, whilst still being within the spirit of LPAD testing. Full details of this procedure can be found in Appendix 2B.

Using Shayer's specific 'cut-off' criteria, it is possible to gain an estimate of unassisted performance without incurring undue concern on the part of the subject. Mediation is then provided on the LPAD Variations and Raven's matrices are given to the subject for a second time (as an unassisted follow-up), but only from the point where he or she previously began to fail.

Raven's SPM is therefore given twice within the test session. The first administration gives an indication of the subject's baseline level of unassisted competence. The second administration (given after the LPAD Variations) indicates the subject's ability to profit from the mediation. If the skills acquired as a consequence of mediation are transferable, they will be reflected by an increase in total score on the second administration of the matrices. The difference between the two scores represents a 'modifiability' estimate. Raven's (1981) norms can be used to determine what this change in performance means in terms of the subject's mental age and percentile rank order (see below).

THE METHODOLOGY IN PRACTICE.

The procedure was tested on a group of children from the remedial department of a mixed comprehensive school in Dorset. Three cases have been illustrated in Table 6. The results are given in terms of their mental ages, (i.e. where 50 per cent of children of the same age are expected to achieve the same total score), and in percentile points, where a student's performance is ranked against children of the same chronological age. Both measures are taken from the Raven's SPM manual (Raven 1981).

Table 6 : Using Raven's SPM to estimate change: 3 examples.

Name	David	Russell	Lee
Age	13	13	11
Raven's total (before)	28	25	20
Raven's total (after intervention on LPAD)	34	32	45
Mental age (before)	8y.2m.	8y.0m.	7y.4m.
Mental age (after)	9y.4m.	9y.0m.	13y.5m.
Percentile point (before)	5	4	2
Percentile point (after)	13	9	77
Difference			
Mental age gain	1y.2m.	1y.0m.	6y.1m.
Percentile point gain	8	5	75

The transfer effects of the mediation on the LPAD items are not homogenous for all pupils: David 'gains' one year and two months and moves up eight percentile points in relation to his peers; Russell 'gained' one year and moved up five percentile points; but Lee 'gained' a phenomenal six years one month and moved 75 percentile points ! Lee's performance emphasises the need for normative data since it is far more impressive for someone of his age to be able to solve the harder items than if an older child obtained the same total score. (This is reflected by the percentile rankings for children of different ages).

Lee was an interesting case. He had missed a great deal of schooling due to repeated operations on his leg and was as a result so behind in class that he was moved to the remedial department. His teacher asked me to assess him to see if he really was a slow learner or whether it was because of his having missed so much schooling. On the initial test he was scoring at a level corresponding to the bottom second percentile for his age group. On this basis his present placement would be correct. However, after training on the strategies relevant to the LPAD items, his performance improved to the 77th percentile which is well above average for his age (a performance which could be expected from someone aged 13 years and 5 months).

A system which included a comparison of age norms was very attractive since it accommodated the fact that during the course of the experiment all the subjects were going to grow a year older. After a year one one would expect the children to change anyway but fortunately their rank order, or percentile point, should remain constant. Changes occurring over and above those resulting from increased age and experience, that is those induced by IE instruction, would be shown by an increase in percentile ranking.

STRATEGY ADOPTED FOR LPAD TESTING.

The Raven's Standard Progressive Matrices problems, with LPAD Variations, were given to each child individually and during a separate test session to the Representational Stencil Design Test. On the first occasion the Raven's matrices were administered to the child, unassisted, both before and after the LPAD Variations, using the procedure which has been outlined above. These interviews lasted approximately an hour to an hour and a half. RSDT was given on the second occasion and, depending on ability, it took between half an hour and an hour to administer.

All five series of LPAD Variations problems were given to the pupils. On these questions they were allowed as much mediation as necessary for them to reach the correct solution. The examiner starts by offering the most minimal intervention and gradually increases this amount according to the subject's needs. A fixed sequence of levels of help are available (see the mediational-hierarchy). The details of the pupil's performance (cognitive 'deficiencies') were recorded using the schedule illustrated in Figure 8.

To ensure that the same ground is covered in each interview, the examiner follows a set list of questions which he asks about particular test items (see Appendix 2C for details). For example, if the focus is on the pupil's ability to think hypothetically then the response alternatives are covered up and he is asked to describe what the answer will look like. To look at how the pupil uses logic or language and whether he has understood how to use 'two sources of information', the examiner may ask why one answer is correct or another is not or ask him to explain his answer. The subject may have picked the right answer but only by probing will the examiner establish whether this was by chance or not. To prevent boredom and to reduce the testing time, questions are not asked for every problem on the LPAD Variations, unless the subject has difficulty solving them.

The quality of the verbal response is recorded but it does not detract from the score because this might discriminate against non-indigenous or non-middle-class populations. The examiner records the pupil's choice of response, evidence of cognitive impairments and the level of his own intervention. The same information is recorded for the RSDT.

The RSDT is given in two parts: a training page, consisting of simple 'warm up' stencil designs using no more than three stencils, and a test page, using a maximum of seven stencils in a design. Before the test begins, the subject is made familiar with the format of the test. He is asked to name the colours and the shapes of the 'cut-out' stencils and is made aware that each stencil can be referred to by a corresponding number underneath (refer to Figure 7). A few simple questions are asked about what would happen when the stencils are superimposed on top of each other (see Appendix 2D for details of administration).

Language skills are not of prime concern in this test. The subject needs only to obtain the correct solution by giving the numbers of the stencils that make up the design and in the correct order. However, if the pupil gets the solution wrong the examiner probes to find the reason for the difficulty using the descriptions of impaired functioning (Table 5) as a quide. The names of the shapes and the colours will be used to draw his attention to the mistake, and to guide his search for the correct stencils.

All 20 designs from the training page are given in sequential order. The test page designs are given in order of difficulty, based on the number of stencils and colours involved. The most difficult items are those with a large number of stencils but only a few colours. If the training page has been mastered without difficulty, then the pupil is allowed to omit the first few items on the test page, since he has already completed items which are harder than these. Because of the greater complexity of the designs on the test page, the test is terminated once the pupil has difficulty responding to mediation, in order to avoid a sense of failure (the administration details are given in Appendix 2D).

PREDICTION OF MODIFIABILITY.

There is some confusion over the meaning of 'modifiability' in the practical terms of changes in pupil performance. If, as Feuerstein et al (1981A) claim, Instrumental Enrichment increases an individual's ability to profit from direct exposure to learning situations, then his potential for change, or his 'modifiability', should increase after IE instruction. On the other hand, if IE remediates a child's cognitive deficiencies then presumably he will be able to use his cognitive processes more efficiently. In this case we expect the gap between what he does do and what he can do to close because he is now performing maximally. Thus the potential for 'modifiability' could be described as less that it was.

Both of these alternatives predict that after receiving appropriate mediated learning experiences, the pupil will have improved his performance in absolute terms. However, the question is whether or not more IE actually increases or decreases the 'modifiability' estimates of pupils exposed to it.

Presuming that IE alters cognitive performance, these predictions can be tested using the Raven's and LPAD Variations procedure outlined in this chapter. If Feuerstein is correct, then pupils who have received IE should, as a result of the mediation provided on the LPAD Variations, make greater gains on the second administration of Raven's matrices than they did using the same tests before the experimental programme began. If he is not correct, the IE group will also begin at a higher level than they did on the pre-test, but, the mediation on the LPAD Variations in this case will not result in as much change in correct scores on the second administration of the matrices (on the post-test). It should also be extremely interesting to see if the post-test 'modifiability' estimates for the IE group differ from those of the control group, who have not had structured mediated learning experiences.

CHAPTER 3

THE ASSESSMENT OF IE TRAINING

CHOICE OF TESTS

Since the Learning Potential Assessment Device and IE instruments are built on the same cognitive model, it was thought desirable that the assessment should aim to describe changes in performance as closely as possible in terms of this model.

Some of the IE materials have a content which resembles that of some IQ tests; it is therefore not sufficient to justify the success of IE solely on the basis of increased IQ scores. For this reason a wider battery of tests was chosen to test how these effects transfer both in relation to the parameters of the cognitive map, as revealed by the Piagetian and psychometric measures of performance, and in terms of the general aims of school tuition. Tests of school achievement which are appropriate to the assessment of the low functioning have also been administered.

In addition to the types of tests already mentioned, Feuerstein's LPAD Variations and Representational Stencil Design Test were also given to the participants in this study. These tests provide information about specific areas of cognitive deficiency and on pupils' responsiveness to intervention, that is their 'modifiability'. These results will be discussed separately.

PIAGETIAN TESTS

One of the subgoals of Instrumental Enrichment is to enhance a pupil's acquisition of 'operations'. A battery of ten concrete operational tasks was given to test whether or not the operational skills of those children exposed to IE are accelerated in relation to those of the control group. The use of these Piagetian tasks thus provides an independent measure of the Operation parameter of the cognitive model.

It is possible to increase an individual's IQ score through intervention without changing the way in which he processes information, and since one of the claims for IE is that it produces such changes, the development of concrete and possibly formal thinking needs to be monitored. The content of these Piagetian tasks is totally dissimilar to that of IE, and hence any gains would reflect genuine development.

The Piagetian battery used in this study consists mainly of concrete-operational tasks (Appendix 3A). It was developed for a project in Pakistan for which Michael Shayer acted as a consultant. Dr. Shayer's notes on the development of this battery and its administration and use in this study can be found in Appendix 3B. On the post-test administration it was necessary for Shayer to add some formal operational tasks to the battery; the details are provided in this Appendix (3B). Shayer has also established a procedure for converting the subjects' obtained Piagetian 'levels' into Mental Age Scores (see Appendix 3C).

PSYCHOMETRIC TESTS

The SRA Primary Mental Abilities test (PMA), developed by Thurstone (1954), is a psychometric test which measures intelligence in terms of recognised mental abilities: Verbal, Spatial, Reasoning, Perception, and Numbers. These roughly correspond to the Modality parameter listed round the circle in the cognitive model (p. 45), and represent the mode of communication through which material can be assimilated.

If the effects of IE are differentially beneficial across the range of abilities, then this would be demonstrated by a different profile of performance for an individual, before and after he received IE tuition, on the Thurstone PMA.

Thurstone's PMA was attractive for a number of reasons. Firstly, it has already been used to evaluate the IE programme in Israel and the USA and hence the results of this research should be compatible with work already carried out. The remaining advantages concerned the actual test construction. The PMA is a group test which has been adapted for three age ranges, of these the 7-11 year old range was considered to be the most appropriate for a slightly retarded population of adolescents. The test comprises seven sub-tests which take eight minutes or less to administer and, apart from the two timed sub-tests, the emphasis is on <u>power</u> rather than <u>speed</u>. The scores for each test are recorded in terms of mental age up to age fourteen, although an IQ score can be estimated.

The mental abilities are said to be relatively independent of each other and so use of the PMA allows one to check the consistency of functioning across the various abilities. This provides an indepedent monitor of a child's progress within the modalities as described by Feuerstein.

ACHIEVEMENT TESTS

After consultation with the Headmaster at the ESN(M) school, where IE is being carried out, tests of reading, mathematics and basic skills were chosen for their relevance to the school success of low-functioning individuals. Instrumental Enrichment does not aim to teach the specific skills required for reading or mathematics, they are nevertheless an important part of the school curriculum and should therefore be investigated. Improvements here may take longer to manifest because they are secondary to a general increase in processing ability.

If the programme is to claim success then the effects must be demonstrated outside the confines of an IE lesson, in particular one would hope to see changes in areas of vocational significance for the child.

Neale analysis of reading ability (Neale 1981)

The NEALE reading test is suitable for children with a reading age from six to thirteen years of age. The test is administered to individuals and although it is not timed it lasts approximately 10-15 minutes. The test takes the form of six oral reading scales graded in terms of the difficulty of the vocabulary, the length of the passage and the complexity of the sentence construction. Three separate scores are then recorded in terms of a mental age for a given pupil's rate of reading, the accuracy, and the comprehension of the passages.

NFER mathematics attainment A.B. or C1 (NFER 1978A)

Tests of mathematics attainment A, B or C1 were given to the pupils in accordance with the teacher's estimation of their ability and in cases of doubt two adjacent tests were given. All of these are group tests and the particular advantage for this population is that the teacher reads the questions out to them. This is important since otherwise the poorer readers would be penalised for reasons not related to their mathematical ability. Test A is designed to cover the abilities of 7-8.06 year olds and takes 40 minutes on average to administer (the range is 30 to 60 minutes depending on the ability of the children). Test B covers 8-10 year olds. It takes approximately 45 minutes to give with a range of 35-70 minutes. Test C1 was only given to the most able pupils, it was designed for 9-12 year olds and takes 50 minutes on average.

Richmond Test of basic skills (France & Fraser 1975)

The work studies section of the Richmond test of basic skills tests aspects of 'methods of study' relating to the ability to read maps (Test W1), and to read graphs and tables (W2). These were given at Level 1, corresponding to the 8.01 to 9.00 year old ability range. W1 takes half an hour to administer and W2 takes 20 minutes. They can be given in group form, although children with low reading ability may need close supervision. These tests are more likely to involve the kinds of cognitive functions addressed by IE, for example precision, planning, orientation, and instructions, than other tests of academic achievement. However, the particular skills of map reading and so on are not taught directly in the IE programme.

The Piagetian, psychometric and school achievement tests provide a record of a child's unassisted performance level. By observing the changes in the experimental group in relation to those of the control group, the effects of IE can be assessed. Use of the first two tests yields information on the Operation and Modality parameters of the cognitive map, whilst information on the cognitive functions, as outlined by the Phase parameter, can be gained from studying the LPAD test results (see Chapter 4).

METHODOLOGY

The Piagetian battery, Thurstone PMA and tests of achievement were given to the experimental and control groups in October 1982, at the beginning of the IE programme. A single class was randomly assigned either to the experimental group, who received between 2 and

3 IE lessons per week, or to the control group (who received their own brand of cognitive training initiated by the class teacher). The experimental subjects were not taught by their regular classroom teacher for the IE lessons.

Originally IE classes were also established in a second school but these had to be discontinued because of internal crises within the school. This left a small sample of 18 subjects in the first school (8 experimental, 10 control). Of these, three pupils had to be disqualified because of prior exposure to the IE programme and a further two, one from each group, withdrew after the first year when they were transferred to different schools. The final sample included six experimental and six control subjects.

Both groups were retested, using the same measures, eighteen months later. The post-test results are reported in Chapter 5.

THE PRE-TEST RESULTS (PIAGETIAN, PSYCHOMETRIC AND ACHIEVEMENT)

The pre-test results have been corrected so that subjects have only been included in the analysis if they were present at both the pre- and the post-testing sessions; this made little difference to the results.

Two-tailed 't' tests of significance were carried out on the pre-test Piagetian, psychometric and achievement measures of performance. The results are reported both in terms of the level of statistical significance and in terms of the differences between the means, given in standard deviation units, of the two groups (Appendix 4A). A negative result means that the experimental group is starting in a lower position. This has also been represented graphically (see Appendix 4A).

The most important difference in the performances of the two groups occurs in their Piagetian operational level of functioning. Although the difference is only statistically significant at the .20 level, there is a 0.62 standard deviations difference between the means in favour of the control group. The Piagetian battery yields an extremely sensitive measure of performance and a difference of this magnitude is meaningful in terms of the levels of operational functioning of the two groups.

On all the other tests the differences fall below the .20 level of significance with less than 0.5 standard deviations difference between the means of the two groups. In terms of mean differences the advantages are roughly equivalent for the two groups: eight sub-tests tend to favour the experimental group and five tend to favour the control group. As it happens two of the reading sub-tests reveal a slight advantage for the control subjects but the mathematics and basic skills tests indicate a slightly better performance by the experimental group (see Appendix 4A).

The raw data for all these tests may be found in Appendix 4B.

CHAPTER 4

THE LPAD PRE-TEST RESULTS

The LPAD Variations (with Raven's matrices) and the Representational Stencil Design Test were administered on an individual basis, using the procedure outlined in Chapter 2. They were given in May 1983, six months after the IE programme had begun. It would have been desirable to have given these tests at the same time as the Piagetian, psychometric and achievement battery but the state of the LPAD testing technique was not sufficiently developed at the time (October 1982). The problems caused by the ambiguity of the LPAD model and the lack of standardisation of the LPAD battery have already been mentioned in Chapter 2. In March 1983 I visited the research institute in Jerusalem to attempt to resolve some of these difficulties, in consultation with Professor Feuerstein, before LPAD testing could begin.

The late introduction of the LPAD tests works against the research hypothesis, that the experimental group will have shown more remediation of their deficient cognitive functions than the control group after exposure to IE. If the IE programme had already begun to induce changes in cognitive functioning, before the pre-test measures had been taken, then these differences would not show up as pre- to post-test change. The estimates of 'modifiability' for the experimental group may also be affected. However, one would not expect IE to have such immediate effects and the pre-test data, which will be discussed later, indicates that the differences between the experimental and control groups are not statistically significant but the slight differences that do exist, if anything, tend to favour the control group.

The data from the first testing session can be divided into two parts: one which concerns evidence of cognitive functioning, as indicated by performance on the LPAD Variations, and the other the 'modifiability' estimates gained by giving Raven's matrices as an unassisted test both before and after the LPAD Variations (where mediation was available).

Raven's matrices (Estimates of 'modifiability')

Table 7 shows the gains made on the Raven's matrices as a result of exposure to mediation on the LPAD items. The results are given in terms of the total number of items scored correctly (out of 60), mental age, and percentile point scores. Raven's (1981) norms have been used. The mental age scores reflect a performance which corresponds to the 50th percentile of that age group which achieves the same total score as the subject. The percentile point score ranks the subject's performance against those of children of the same chronological age. The 'gain' scores are the difference between the subject's performance on the first and second administration of Raven's matrices.

The results for all the subjects on the first administration were quite uniform. The performances roughly corresponded to those which could be expected from 'average' eight year olds. The results after the second administration however varied quite considerably, even for children with the same initial score. Thus Jason, Pamela and Alan all got 26 correct answers on the first administration but, after mediation on the LPAD items, their scores increased to 29, 37 and 46 respectively. In terms of mental ages, these are equivalent to gains of three months, one year ten months and an incredible six years! Alan showed himself capable of performing at a level which could be expected from average children of his own age, and his rank order amongst them increased from the 4th to the 53rd percentile.

TABLE 7

Pre-test gain scores on Raven's matrices (Experimental & Control)

Name	Age	Total score			Mental age			Percentile point		
	*y.m.	(1)	(2)	gain	(1)	(2)	gain y.m.	(1)	(2)	gain
Exp.										
Philip D.	12.10	25	33	8	8.00	9.03	1.03	5	12	7
Neil F.	13.07	23	37	14	7.08	9.10	2.02	2	12	10
Paul G.	13.01	24	28	4	7.10	8.02	.04	3	5	2
Craig J.	12.09	27	42	15	8.01	12.07	4.06	5	47	42
Terry M.	13.00	30	36	6	8.04	9.08	1.02	7	18	11
Martin T.	12.11	15	19	4	<6.06	7.03	.09	1	1	0
Control										
Sean C.	13.01	30	36	6	8.04	9.08	1.04	7	18	11
Jason G.	12.09	26	29	3	8.00	8.03	.03	5	7	2
Michael K.	12.10	33	41	8	9.01	12.00	2.09	12	40	28
Pamela M.	13.05	26	37	11	8.00	9.10	1.10	4	12	8
Alan N.	13.05	26	46	20	8.00	14.00	6.00	4	53	49
Marc S.	13.02	31	35	4	8.06	9.06	1.00	7	13	6

Notes :

* years and months

(1) first administration of Raven's matrices
(2) second administration of Raven's matrices

gain = the difference between (1) and (2)

< Martin scored below the 50th percentile,(38th) of 6.06 year olds on the first administration.

The Raven pre-test results for both the first and the second administration tend to favour the control group: in terms of total score, there is a difference between the means of the two groups of 0.79 sd on the first administration and 0.49 on the second. This is also reflected in the percentile ranking. Using the standard Arcsin transformation for calculating differences in percentile ranking, the control group maintain a 0.75 sd average lead on the first administration and a 0.38 lead on the second. The Arcsin transformation weights percentile ranking according to the magnitude; the larger the rank the larger the weighted score.

The pupils' performances on Raven's matrices may be used to give an indication of 'modifiability'. The initial scores may be grouped under three headings: low, medium and high. The gains made on the second administration may be similarly grouped. For example, Martin would be considered to be both a low starter and a low gainer. In his case one would not expect IE to alter his estimate of 'modifiability' (made at the post-test). Alan, on the other hand, is considered to be highly modifiable.

It will be interesting to see how IE has influenced these estimates of 'modifiability' on the post-test. Terry and Sean, for instance, have both started from the same position and made exactly the same gains, but only one of them receives IE. As previously stated, it is the intention of this study to use the post-test results to determine whether, as a result of IE, the experimental group actually become <u>more</u> or <u>less</u> modifiable. See Table 8 for the pre-test estimates of 'modifiability', based on the results of the first and second administration of Raven's matrices.

TABLE 8 Pre-test estimates of 'modifiability' (Using Raven's Matrices)

'MODIFIABILITY' \ INITIAL SCORE	Low	Medium	High
Low	(E) Paul (E) Martin	(C) Jason	(C) Marc
Medium	(E) Philip	(E) Terry (C) Sean	(C) Michael
High	(E) Neil	(E) Craig (C) Pamela (C) Alan	

(E) Experimental
(C) Control

Initial scores

Low = less than 25 correct
Medium = 26-30 correct
High = above 31 correct

'Modifiability' (Gain)

Low = less than 4 more correct
Medium =between 5 and 10 more
High = above 11 more

The LPAD Variations

There are five series of LPAD Variations (A-E), and in each one there are seven matrix problems. All the subjects completed this part of the test. Evidence on 'deficient' patterns of cognitive functioning as described in the Phase parameter of the cognitive map, were recorded together with the level of examiner intervention, according to the sequence of help outlined in the mediational-hierarchy (Chapter 2). The experimental and control groups' performances from the recording schedules have been summarised in Appendix 4C Table 1: "Evidence of 'deficient' cognitive functioning on the LPAD Variations". The level of mediation needed by each subject to complete these items has been recorded separately (Appendix 4C, Table 2).

A major problem has been to find appropriate ways of representing the information from the LPAD Variations. The lack of normative data on task complexity has been a considerable handicap: since the tasks have not been graded for their difficulty, it means that scores which would reflect a subject's learning, that is a decrease in the amount of mediation offered as the test progresses, are confounded by increases in task complexity. It was therefore decided to look only at the overall mediation level for the test as a whole.

The LPAD Variations comprise three basic types of question (Appendix 2C): those which require the subject to verbalise his reasons for choosing a particular solution; those which require him to predict the solution; and those which he is allowed to solve without explanation. The latter group, consisting of eleven questions, were selected intuitively as being less difficult than other members of the series, thus the testing time could be reduced without losing too much information on the patterns of cognitive functioning. These questions were, however, discounted from the analyses.

The mediation levels of the other two types of questions were compared and were found to be similar. This is not surprising since the ability to predict the solution to a matrix problem, 'hypothetical thinking', necessarily depends on the ability to use 'two sources of information' (Feuerstein's categories of cognitive 'deficiencies' overlap to a considerable extent). It was therefore decided to analyse the data from these 24 questions together.

No significant pre-test differences were found between the average amount of mediation needed by the experimental and control groups to solve all the LPAD items; ($t = 1.535$, with 10df, $p < .20$). However there is a 0.63 sd difference between the means of the two groups, in favour of the control subjects.

The next stage involved grouping the response patterns according to whether they had been good, adequate or whether there was evidence of impaired cognitive functioning in relation to three aspects of performance: 1) Egocentric communication and the quality of the verbal response; 2) Appropriate sources of logic and sufficient sources of evidence to support an answer; and 3) Impulsivity related problems (including trial and error or blocking behaviour), which may occur with or without the ability to use two sources of information when solving matrix problems. The frequency of occurence of the response patterns, in relation to each of the aspects of performance, has been recorded in Appendix 4C, Table 3.

The total score has been weighted to reflect the quality of the response pattern: a poor response receives a score of 2, an average response receives a score of one and a good response a zero score.

Thus the higher the total score, the poorer the overall pattern of responding.

For example, on the Logic/Sufficient evidence aspect of performance, if on one question the examiner had to direct the subject's attention to the appropriate sources of logic and later had to provide the complete answer (or a large part of it) the response would be considered poor and would receive a weighting of 2. If the examiner had directed the subject's attention but the subject was then able to provide the appropriate rationale, or if the subject used the relevant sources of logic but missed out some of the information, then this would be considered adequate and would receive one point. Lastly, if both the logic and use of evidence were good then the score would be zero. This information would already have been coded on the recording schedule and would look like:

Logic	E E	E ▲	▲	E = Examiner supplied the answer
Sufficient evidence	E ✓	▲ ✓	▲	✓ = Evidence for deficient cognitive function
(Weighting)	2	1	0	▲ = Good use of cognitive function

Similar criteria are used for the other two aspects of performance (see Appendix 4C, Table 3). The 'weighting' of the scores reflects, to some extent, the level of assistance (as measured on the mediational-hierarchy) and the record of deficient cognitive functions, since the hierarchy is used in the test interview as a guide to the severity of the pupils' cognitive impairments.

The differences between the experimental and control groups' weighted response patterns tend to favour the control group. For the Egocentric communication/Language aspect of performance there was a 0.14 sd difference between the means (t = 0.33 NS); for Logic/Sufficient evidence, this difference was 0.85 sd . (t = 2.09,

$p < \cdot 10$) and for Impulsivity errors/Use of two sources of information it was 0.58 sd ($t = 1.42$, $p < \cdot 20$).

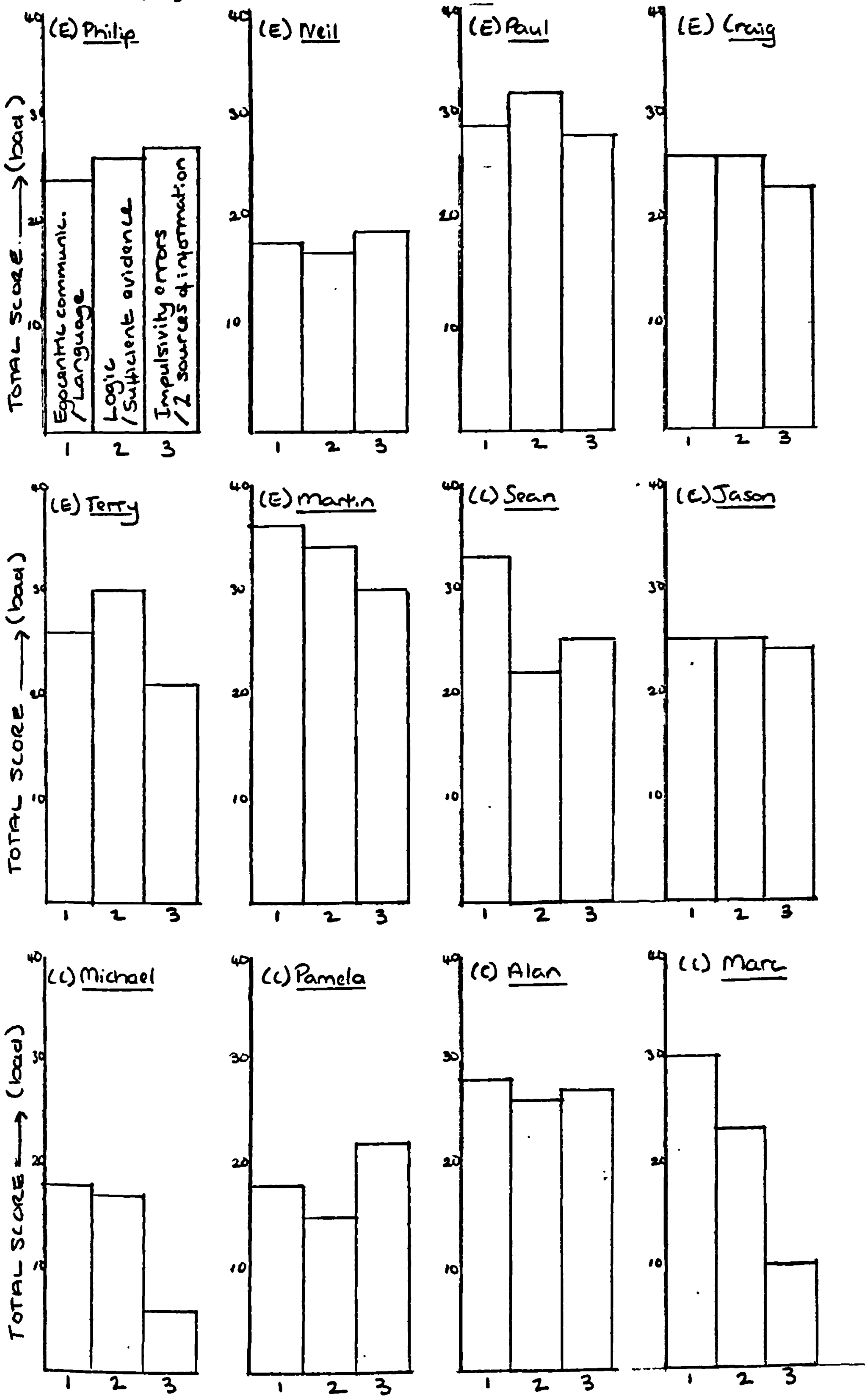
Figure 11 shows the subjects' weighted responses to the three aspects of performance. The responses seem to be fairly uniform across the three aspects, but again this is not surprising since Feuerstein's cognitive functions are inter-related: one's understanding of how to use 'two sources of information' to solve matrix problems is likely to be reflected by the type of evidence used to support the answer and in the way the answer is communicated.

There are however some individual differences: Martin has a high score on all three aspects of performance, which indicates impaired cognitive functioning, whilst Michael has a relatively low score on all three. Overall Michael gave the best performance on the Variations. There are also differences within individual responses: Marc's understanding of the use of 'two sources of information' was very good, as reflected in the low score on this aspect of performance, but he had great difficulty in verbalising and explaining his answer. Pamela, on the other hand, found it slightly easier to verbalise and explain the answer, once it had been solved, than she did to solve the item in the first place, indicated by a higher total on the 'two sources of information' aspect of her performance.

The frequency data of typical response patterns (good, adequate or poor), gives a clearer idea of individual differences. These are given in Appendix 4C (Table 3) but they are also illustrated by bar charts which have been drawn separately for each of the aspects of performance. These can also be found in Appendix 4C, Figures 1, 2, and 3.

The LPAD Variations post-test results can therefore be assessed to see if Instrumental Enrichment changes the experimental group's

Figure 11 : Pre-test response patterns on the LPAD Variations (Experimental & Control)



(E) Experimental (C) Control

response patterns in relation to the control group's and whether the IE group show more remediation of their 'deficient' cognitive functions.

The Representational Stencil Design Test (RSDT)

The RSDT is a very good test of errors related to impulsivity, a lack of precision and the ability to think hypothetically. However, despite having relatively clear behavioural correlates for impaired cognitive functioning, the data have been extremely difficult to analyse. Once again the stumbling block has proved to be the lack of normative data. This affects all the tests in the LPAD battery. Measures of learning, or 'modifiability', over the course of the test are confounded by increases in task complexity.

There is an additional problem. Because of the great difficulty of some of the items on the test page, even for 'normal' adults, it was not possible for every subject to complete them all and the test had to be terminated after a certain number of failures. (See Appendix 2D for the administration details). It was therefore not possible to directly compare the frequencies of observed 'deficient' cognitive functions of subjects who completed different amounts of the test. The raw data concerning these frequencies has been recorded separately for the RSDT training page, which everyone finished, and the test page (see Appendix 4C, Tables 4 and 5).

The items on the test page had been grouped (intuitively) into clusters of those of equal difficulty and it was originally intended to compare pupils' response patterns within each group of items. This was not possible for two reasons: firstly, because of the small number of items in each group, the measures of response patterns were not thought to be reliable; and secondly, and more importantly, an inspection of the raw data revealed no measures of different aspects of performance. Errors made on RSDT tend to be observed more as a function of task complexity rather than as characteristic of any individual's pattern of responding. That is to say, the same errors usually occur for each subject but at different points in the test. For those that found the test hard the errors relating to impulsivity, precision and a lack of hypothetical thinking were revealed early on, whilst for those that found it easier, the same errors appeared later.

Most of the subjects completed the training page without difficulty - the average number of unassisted items correct was 13/20 - so it would not have been fruitful to confine the comparisons of impaired functioning to this part of the test. Regrettably, it was decided that the pre-test RSDT data on the deficient cognitive functions could not be analysed in a useful or meaningful way. The recording schedules of a poor, an average and a good subject have been included in Appendix 4C (Figures 4,5 and 6), to illustrate some of these points.

Analysing the mediation scores, to obtain estimates of 'modifiability', was difficult for many of the same reasons; for example, someone who had completed only the first group of items on the test page may receive a lower average mediation score than someone who completed two or three groups because of the increasing difficulty of the items. The idea of using some compound variable like, for instance, the level of difficulty of the item divided by the amount of mediation required for success seemed attractive but there was no way of justifying it. The small number of items within each level of difficulty meant that it was not possible to relate the mediation scores directly to the level of task complexity.

An alternative approach is to define a level of mediation and measure the number (ordinal) of items successfully completed at that level. Our best estimate of 'modifiability' is therefore to judge the amount a subject has profited from mediation by determining the gap between the number of items on which he succeeds after a moderate amount of intervention until he begins to need substantial help. In this case, these levels have been set at mediation level three, which corresponds to the moderate amount of help, and level seven which is considered to be substantial (on the 10 point mediational-hierarchy scale).

The initial performance can be characterised as low, medium or high, depending on the number of items which the subject solved correctly before he begins to need moderate help. The unassisted score therefore gives a measure of present competence. The technique used to calculate 'modifiability' was to compute a running mean of the amount of mediation needed on three successive items. These were then plotted and the ordinal number of the item corresponding to the moderate and substantial amounts of mediation were read from the graph. (See examples in Appendix 4C, Figure 7.) The difference between the two points gives the estimate of 'modifiability'. The higher the gap, the more modifiable the subject is considered to be. The results are recorded in Table 9. The decision criteria for establishing the level of unassisted success and the points of moderate and substantial mediation for the RSDT test items are given in Appendix 4C, Figure 8. The subjects' mediation scores per item can also be found in Appendix 4C (Table 6).

This approach to estimating 'modifiability' is similar to the one used to measure 'modifiability' using Raven's matrices (refer to Table 8). Thus we have different combinations of low, medium and high initial scores (equivalent to the unassisted scores in RSDT), with

Table 9 : Pre-test estimates of 'modifiability' using RSDT (Experimental & Control)

Ordinal number of items successfully completed :

	Unassisted Success.	Moderate mediation Level 3.	Substantial mediation Level 7.	Difference 7-3.	Unassisted competence. *(1)	'Modifiability' estimate. *(2)
Experimental						
Philip	6	7.5	16.25	8.75	Medium	High
Neil	6	6.25	11.25	5	Medium	Medium
Paul	3	8.25	10.5	2.25	Low	Low
Craig	7	8.25	19	10.75	Medium	High
Terry	8	9.25	17	7.75	Medium	High
Martin	1	2.5	4	1.5	Low	Low
Control						
Sean	7	7	8.5	1.5	Medium	Low
Jason	3	3.5	10	6.5	Low	High
Michael	11	15.25	20+	4.75+	High	(Ceiling effect)
Pamela	7	8.25	10.75	2.5	Medium	Low
Alan	3	3.25	5.5	2.25	Low	Low
Marc	6	6	14	8	Medium	High

*(1) Unassisted competence
Low = 0-3 items
Medium = 4-8 items
High = 9+ items

*(2) 'Modifiability' estimate
Low A difference of less than 3 items
Medium A difference of between 3-5 items
High A difference of above 6 items

low, medium and high estimates of 'modifiability', which reflect 'gain' after exposure to mediation, for both experimental and control subjects. There is considerable variation between the effects of mediation on the subjects performances. The difference between the number of items successfully completed with moderate and substantial help range from 1.5 items to 10.75 (Table 9). Once again, the post-test results should show whether Instrumental Enrichment has rendered the experimental group <u>more</u> or <u>less</u> modifiable than they were before.

CHAPTER 5:

THE POST-TEST PIAGETIAN, PSYCHOMETRIC AND ACHIEVEMENT TEST RESULTS

OVERVIEW OF THE ANALYSIS OF THE POST-TEST RESULTS

The original idea behind the research design of this study was to use tests which would provide as much information as possible about changes in a pupil's performance in relation to the different aspects of Feuerstein's cognitive model. This would indicate whether, if IE works, it does so for the reasons outlined in the model, namely whether IE increases the level of operational functioning, corrects deficient cognitive strategies and improves an individual's performance across the different modalities.

With the benefit of hindsight it was realised that the pre- post-test battery in fact included four different forms of testing:

A) A measure of "fluid" intelligence, as defined by Cattell (1971), can be obtained from the Piagetian tests and from the performance aspects of the LPAD Variations, as indicated by the unassisted scores on Raven's matrices;

B) Tests of 'modifiability' corresponding to the Vygotskian notion of the 'zone of proximal development' (Vygotsky 1978, posthumously published);

C) Tests of "crystallised" intelligence (Cattell 1971), represented by the Thurstone test of Primary Mental Abilities;

D) Tests of school achievement, including the NEALE analysis of reading, NFER mathematics attainment and the study skills sub-tests of the Richmond test of basic skills.

The information from B is obtained by examining the differences in performance before and after provision of adult assistance on the LPAD variations and it is therefore reported with the other LPAD results in Chapter 6. Feuerstein's interpretation of 'modifiability' will be discussed in the light of these findings.

In this chapter, the results from the remaining tests are considered to see which of these aspects of intelligence have been most affected by IE training. Both statistical and 'effect size' measures are used: the former as a check on the likelihood that the differences could have occurred by chance; and the latter, which will include mean differences and mental age differences, to assess the importance of the changes. (A mean difference is the difference in terms of standard deviations of the experimental group's change in performance, pre- to post-test, as compared with the control group).

Our own evidence, and that of others, is reviewed in Chapter 7 with a view to estimating:

A) the extent to which IE can be considered to be effective,

B) the extent to which the LPAD model (underlying both IE and LPAD) appears to be validated,

and to suggest future work which may be necessary in order to make the intervention model more effective.

Lastly, in the final chapter, LPAD testing as a clinical procedure will be discussed in the light of the published work of the Feuerstein team (Feuerstein 1979), and of the experience of using it in this study. The aim is both to characterise the virtues of LPAD and to suggest further work which is required if it is to be added to the repertoire of the clinical psychologist.

THE POST-TEST RESULTS

The post-tests were administered in May 1984 after the experimental programme had been running for approximately eighteen months. The subjects had completed on average about 150 of the IE teaching units. In analysing the post-test data we are considering to what extent these results may be attributed to the experimental treatment, IE, as opposed to maturational growth or other influences on educational development. It is therefore necessary to compare the changes, pre- to post-test, of the experimental group with those of the control group and not just the post-test differences betweeen groups. The procedure for testing the significance of the differences between the pre- and post-tests of the two groups has been described by McNemar (1969, pp. 96-98, 116-117).

Since the sample has been matched on the same variable on the pre-test as on the post-test it is necessary to take account of the variability of the means to be expected by successive testing of this kind. Guilford (1956, pp. 166-167) provides the following formula for estimating the Standard Error in such cases:

$$SD_M = \frac{SD}{\sqrt{N - 1}} \sqrt{1 - r_{xx}}$$

where r_{xx} is the test-retest reliability of the measurements on the experimental variable. These reliabilities are generally provided in the test manuals. The above formula gives that part of the Standard Error of Measurement (SEM) which is due to the individuals. It therefore gives a more sensitive indicator of changes in performance that can be attributed to the intervening experiences of the individuals on the two test occasions.

Table 10 :

The difference between the pre- to post-test improvements of the experimental and control groups with respect to the Piagetian battery, Thurstone's PMA and tests of school achievement.

Test	Level of 't'	(p.)	Effect size (sd's)*	
Piagetian battery	4.69	.001	1.22	Tests of "fluid" intelligence
Raven's matrices	4.47	.01	1.07	
Thurstone's PMA				
Verbal-words	-2.95	.02	-0.37	Tests of "crystallized" intelligence
Verbal-pictures	0	ns	0	
Spatial	1.85	.10	0.23	
Reasoning-words	6.79	.001	0.98	
Reasoning-figures	-0.84	ns	-0.26	
Perception	-1.90	.10	-0.35	
Numbers	0.33	ns	0.07	
TOTAL SCORE	-1.12	ns	-0.06	
NEALE reading				
Accuracy	1.71	.20	0.36	Tests of school achievement
Comprehension	0.73	ns	0.26	
Rate	1.58	.20	0.47	
NFER mathematics attainment	1.45	.20	0.21	
Richmond basic skills				
Map reading (W1)	1.71	.10	0.57	
Graphs and tables (W2)	1.54	.10	0.46	

(two-tailed 't' with 10 df)

*Effect size refers to the 'mean difference', in terms of standard deviations, between the pre- to post-test changes in the two sample means.

Table 10 reports the level of statistical significance of these differences and the 'mean difference' in terms of standard deviations (sd), between the pre- to post-test changes of the two sample means. A difference of 0.5 sd and above is considered to be a meaningful 'effect size'. The 't' value has been arrived at using the SEM described above, except in the case of the Piagetian battery for which there is no test-retest reliability measure.

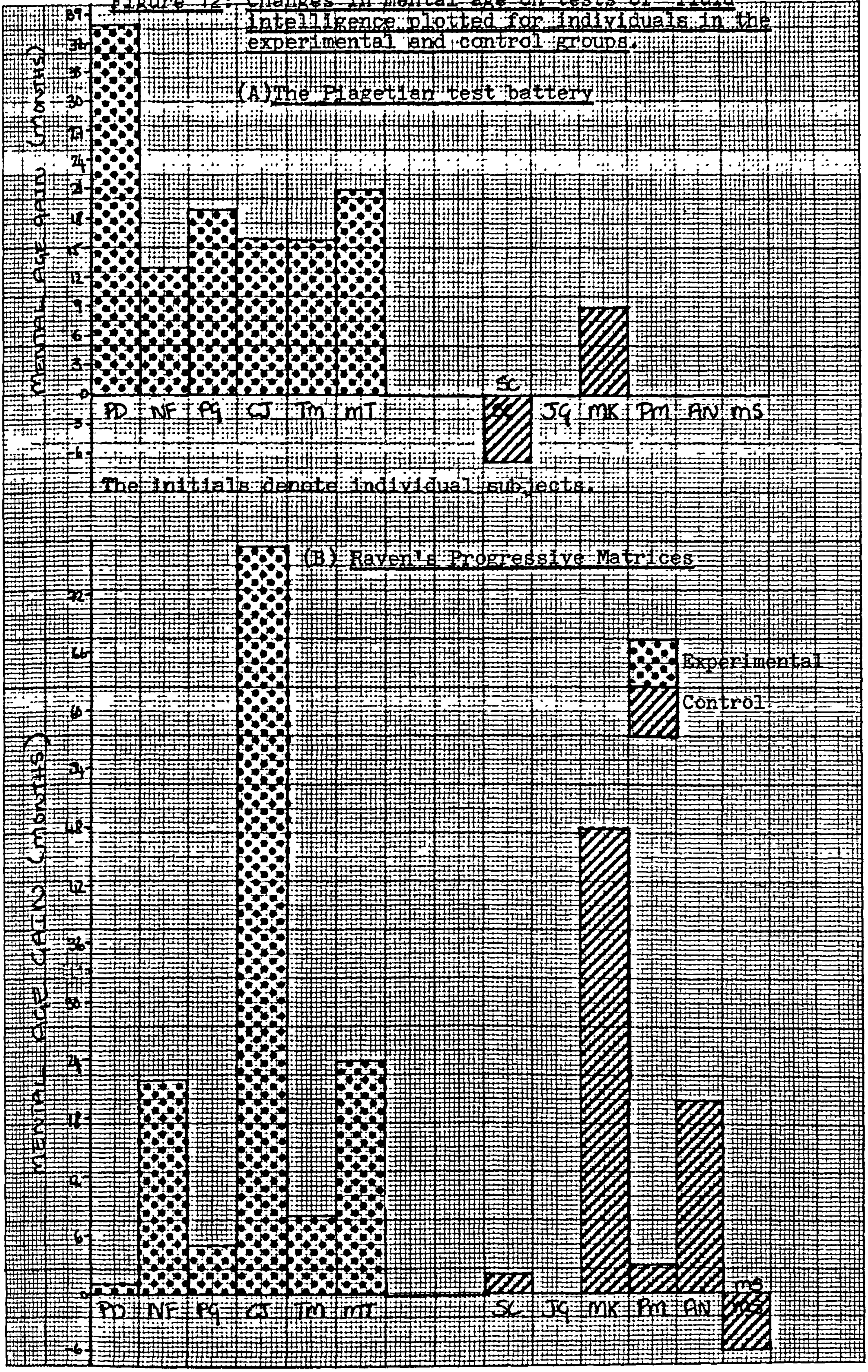
In addition to this, the individual's 'gain' score has been plotted in mental age terms, the most common unit of change for the tests in this battery, for both the experimental and the control groups (see Figures 12 to 14). The reader can therefore see at a glance the overall patterns of responding for each group and any individual variation within these groups. Each pupil is denoted by his initials so that his performance on any of the tests can be easily identified. The raw data for the Piagetian, Thurstone PMA and school achievement post-test results can be found in Appendix 5.

Tests of "fluid" intelligence

The results of the Piagetian battery and the Raven's Progressive Matrices are highly significant both statistically and in terms of the standard deviation difference between the average gains of the two groups. Effects of this magnitude are impressive despite the small sample size.

When translated into mental age scores the Piagetian results represent an average increase of 20.5 months for the experimental groups and only 1.5 months for the control. In fact, only one member of the control group improved his mental age score and then only by nine months. The consistency of the differences between the experimental and control groups can be most clearly seen when their

Figure 12: Changes in mental age on tests of "fluid" intelligence plotted for individuals in the experimental and control groups.



Piagetian mental age gains are viewed side by side, see Figure 12A.

The picture is supported by the mental age gains made on the unassisted administration of Raven's matrices, see Figure 12B. Although these results show more individual variations within each group than do the Piagetian results, there has still been an average mental age increase of 22.8 months for the experimental subjects compared with 11.2 months for the controls. The raw data for the Raven's matrices can be found in Appendix 6 (Table 1).

Clearly there is support for the notion that Feuerstein's IE programme increases the level of 'operational' functioning. Not only have the experimental group made mental age gains which, in the case of Raven's matrices, are over and above the actual time span of the programme, (when it is more usual for adolescent retardates to fall progressively behind their 'normal' peers in school), but also they have reversed a trend favouring the control group on the pre-test measures.

"Crystallised" intelligence measures

The results of the sub-tests on Thurstone's PMA appear to be rather unreliable as independent measures of performance within Feuerstein's modalities. Both groups have made gains and losses but in an inconsistent fashion. This can best be appreciated by looking at the range of individual responses within both groups for the seven sub-tests, see Figures 13 A to G. These bar charts have been plotted in the same units as those for tests of "fluid" intelligence but have been photo-reduced because the range of mental age change is so wide. Since the mental age gain scores are so unevenly distributed within the groups, average mental age gain scores have not been provided.

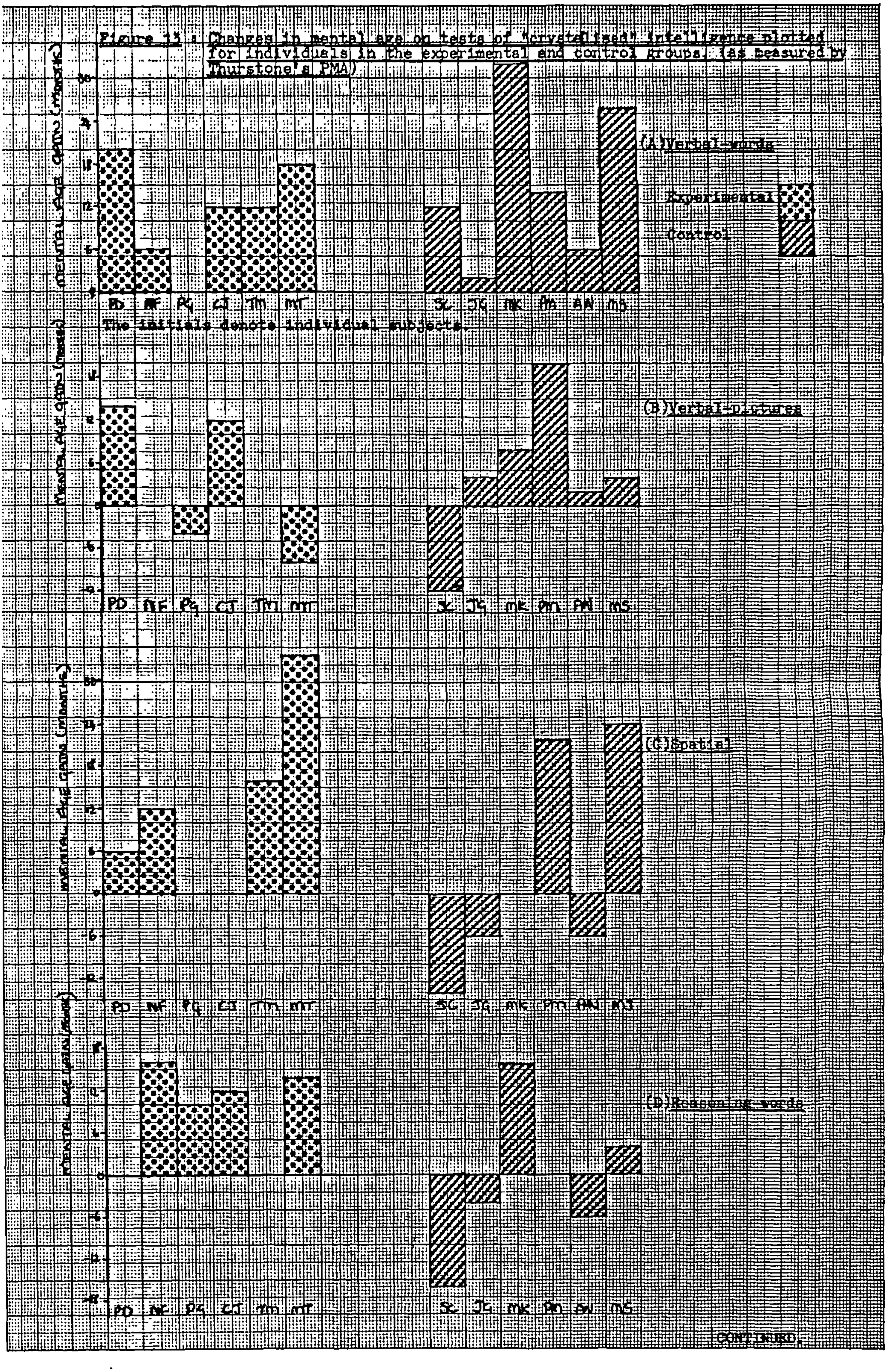


Figure 13 : Changes in mental age on tests of "crystallised" intelligence plotted for individuals in the experimental and control groups. (as measured by Thurstone's PMA)

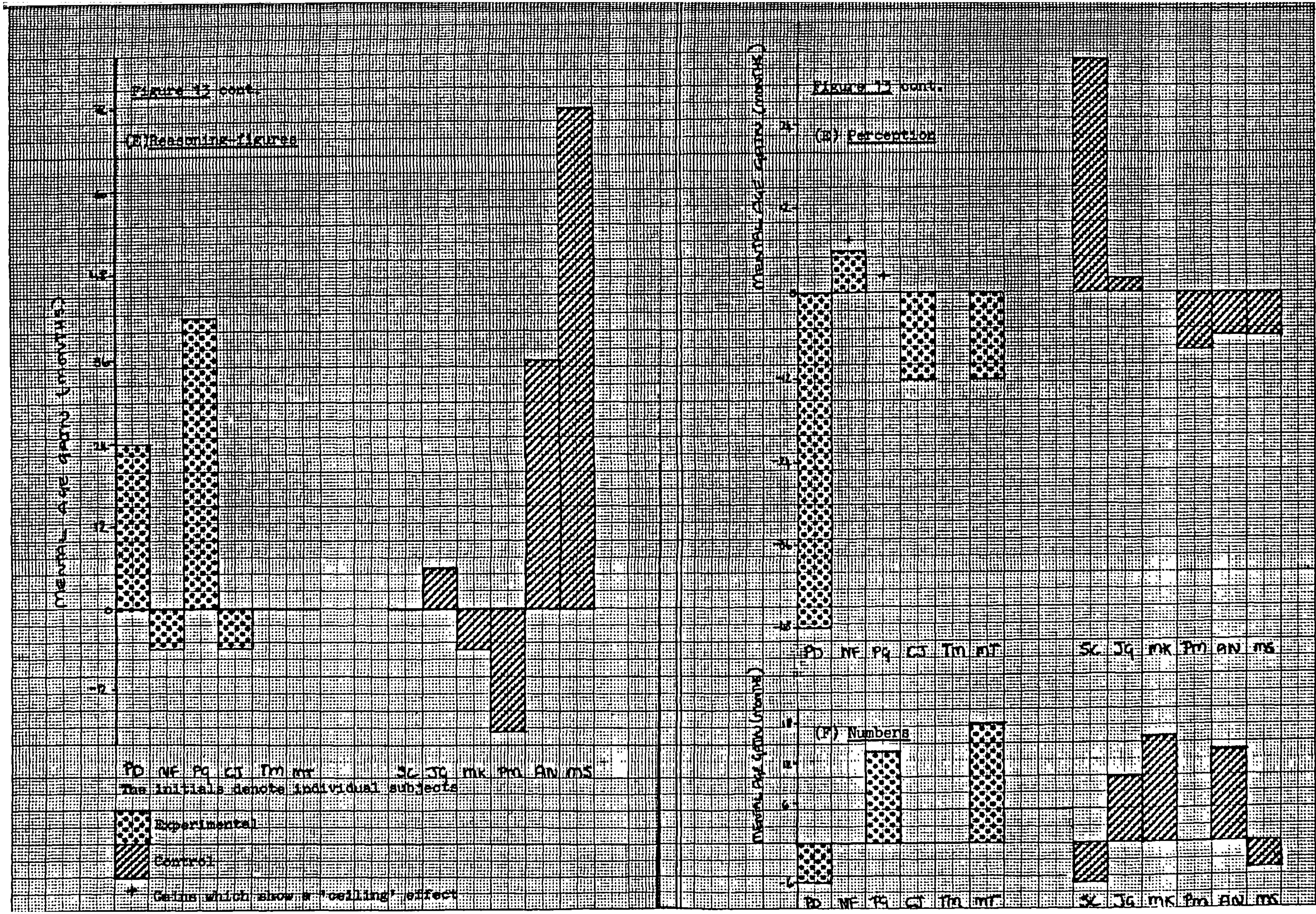


Figure 13 cont.
(E) Reasoning-figures
Mental age gain (months)
PD NF PQ CJ TM MT SC JG MK PM AN MS
The initials denote individual subjects
Experimental
Control
+ Gains which show a 'ceiling' effect
Figure 13 cont.
(D) Perception
Mental age gain (months)
PD NF PQ CJ TM MT SC JG MK PM AN MS
(F) Numbers
Mental age gain (months)
PD NF PQ CJ TM MT SC JG MK PM AN MS

Only the reasoning-words sub-test can be considered to be significant both statistically and in terms of the mean differences between the gains of the two groups. Of the remaining sub-tests, three tend to favour the control group, two tend to favour the experimental group and one shows no difference. However none of these meet the minimal 0.5 sd difference which is considered in this study to be indicative of a meaningful change in performance.

When the total score is calculated there is only a mean difference of 0.06 standard deviations in the mean gains of the two groups. In view of this extremely low level of difference, less overall weight is attached to the statistical significance of the verbal-words sub-test (which favours the control) and the reasoning-words sub-test which favours the experimental group.

Tests of achievement

Both the experimental and the control groups have made some improvements in relation to areas of 'academic' achievement, as shown in Figures 14 A to D. The differences between the groups are not statistically significant, however they all tend to favour the experimental group.

The mental age gain scores for NEALE reading and NFER mathematics appear to be fairly consistent within each group, unlike the 'peaks' and 'troughs' on the Thurstone PMA, and are therefore more likely to represent actual changes in pupil ability levels. The average mental age gains for the experimental and control groups for the component parts of NEALE reading are as follows: for 'accuracy' the differences are 6 months and 4 months respectively; for 'comprehension' they are 10.5 months and 10.2 months; and for 'rate' they are 14.3 months compared with 10.8 months. The average gains for

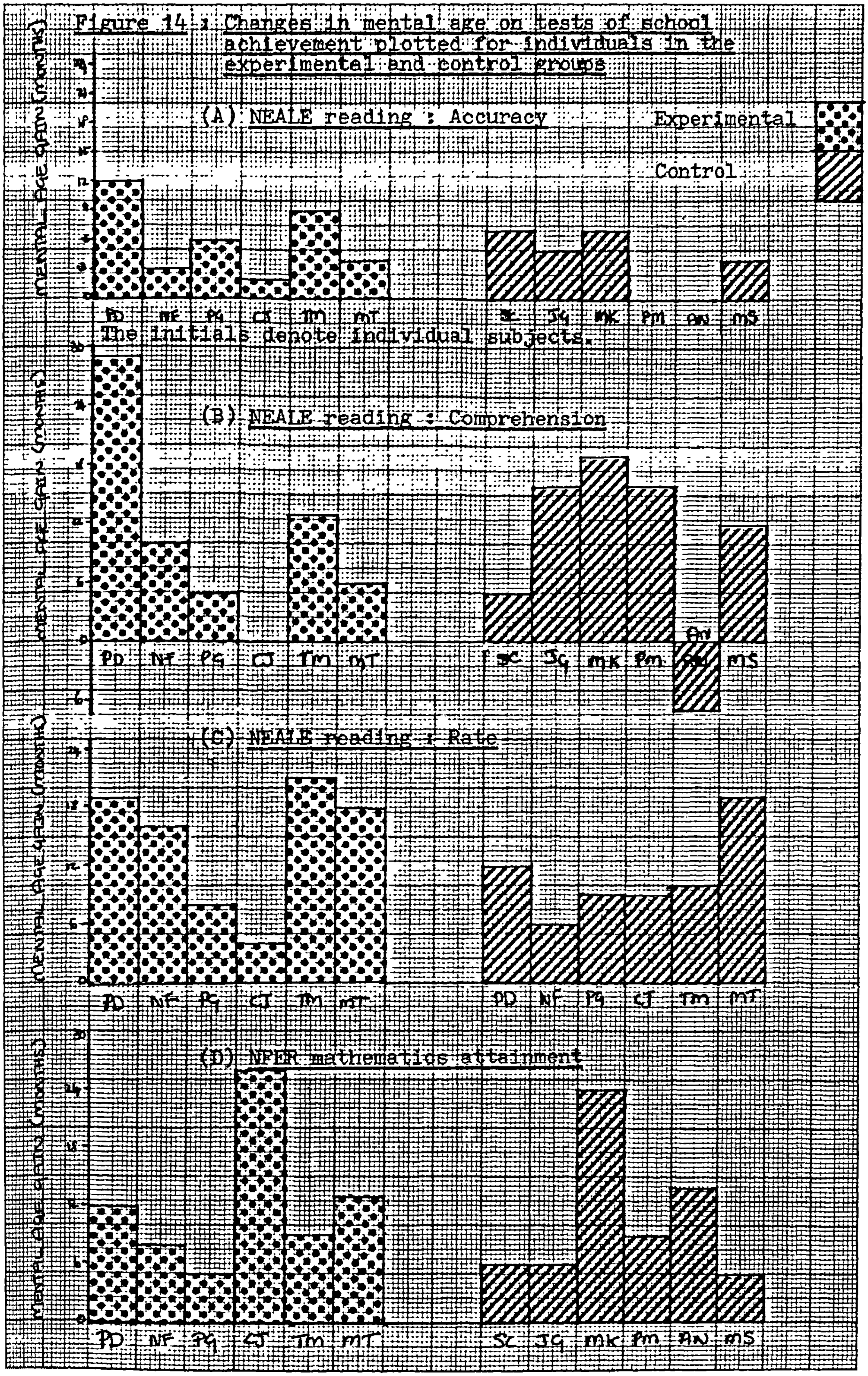


Figure 14 : Changes in mental age on tests of school achievement plotted for individuals in the experimental and control groups

mathematics attainment are of similar magnitude; that is, 12.2 months for the experimental group and 10.7 months for the control. The size of these gains are typical of disadvantaged pupils over an eighteen month period.

The largest difference between the gains of the two groups have occurred on the Richmond test of basic skills. Unfortunately on this test the test norms are not reported in a way that makes it possible to estimate mental age equivalents for a given performance. However, on the map reading sub-test the experimental group demonstrated a 0.57 sd advantage. On the graphs and tables sub-test, which has a higher mathematical component, their advantage is only 0.46 standard deviations.

The results of the achievement tests are in line with the expectations of this study. One would not anticipate that IE would have a dramatic effect in areas requiring specific skills such as reading or mathematics because the programme does not address them. One might expect, however, to see the emergence of improved functioning on basic skills tests because these involve more general thinking skills and strategies, success on the latter does not depend upon any particular knowledge base.

SUMMARY

The results strongly suggest that the IE programme has made its greatest impact in the area of "fluid" intelligence. Apart from the ability to group words (reasoning-words) on the Thurstone PMA, measures of "crystallised" intelligence appear to remain relatively unaffected by this programme as do most of the measures of school achievement. The implications of these findings, and those of others, for IE as a model of intervention will be discussed in Chapter 7.

CHAPTER 6

THE LPAD POST-TEST RESULTS

The LPAD tests used in the pre- and post-test battery provide information on two aspects of 'modifiability': firstly, on an individual's 'zone of proximal development' estimated on each testing session, as measured by his ability to benefit from adult assistance on the test; and secondly, in terms of the pre- to post-test changes in the use of cognitive functions relating to the Phase parameter of the cognitive map. This information is reported separately for the LPAD Variations (used with Raven's matrices) and the Representational Stencil Design Test. The LPAD post-tests were administered in May 1984.

CHANGES IN 'MODIFIABILITY' ON RAVEN'S MATRICES

The idea of using Raven's (1981) norms to measure the amount that the subjects could benefit from assistance was introduced as a means of testing Feuerstein's notion of 'modifiability'. Feuerstein et al (1981A) have claimed that IE increases an individual's capacity for change, that is his 'modifiability'. However, if the child's deficient cognitive strategies are corrected as a result of the programme then the gap between what he is able to achieve with and without assistance might decrease as he begins to function more optimally. This suggests that the individual's capacity for further change may actually decrease.

The intention was to test these predictions by contrasting the pre- to post-test changes in the 'zone of proximal development' for the experimental and control subjects. In the event the methodology employed did not yield support for either hypothesis concerning the effects of IE, the pupils' 'modifiability' estimates (as measured by their ability to profit from adult mediation) had neither increased

Table 11 The difference between the post-test and pre-test results on measures of 'modifiability', using Raven's test norms, for individuals in the experimental and control groups.
(post minus pre)

	(1) First administration			(2) Second administration		
	Total score	Mental age	Percentile rank	Total score	Mental age	Percentile rank
Experimental						
Philip	2	.01	-2	0	0	-5
Neil	12	1.10	6	3	1.02	3
Paul	5	.05	0	6	1.02	3
Craig	21	6.05	61	7	1.11	24
Terry	2	.08	-1	9	3.09	27
Martin	16	2.00	4	19	2.09	13
Control						
Sean	1	.02	-2	3	.02	-2
Jason	0	0	-2	7	1.05	4
Michael	11	4.00	28	7	2.06	26
Pamela	3	.03	-2	1	.02	1
Alan	10	1.08	6	-5	-2.00	-33
Marc	-5	-.06	-5	-7	-1.04	-11

A negative score on the 1st administration means that the subject started from a lower position than on the pre-test. A negative score on the 2nd administration means that the subject made less gains as a result of assistance on the LPAD Variations than on the pre-test.

nor decreased in relation to those of the control group. It did show however that 'modification' had occurred. Significant differences in the pre- to post-test improvements of the two groups have been found to favour the experimental group suggesting that to some extent, their deficient cognitive strategies have been corrected or 'modified'.

In each testing session Raven's matrices have been administered twice, the first administration being before mediation was available on the LPAD Variations and the second administration being after such mediation. Table 11 shows the difference between the first administration during the pre-test session and the first administration during the post-test session some 12 months later. This difference is denoted by (1). Similarly the difference between the second administrations during the pre- and post-test sessions are also shown and denoted by (2). The pre-test raw scores are given in Table 7 (page163) and the post-test raw scores are given in Appendix 6 (Table 1).

In terms of the unassisted gains in total score, (1), both groups have generally improved in relation to the pre-test results. However, there is a difference of 1.07 standard deviations (sd) between the mean gains of the two groups in favour of the experimental group, ($t = 4.47$, $p < .001$). Although some subjects started from a lower percentile point than they had done on the pre-test, this does not mean that their performance decreased in absolute terms (as indicated by the mental age gains), since the standard of the reference group was higher as they were one year older than the pre-test reference group. Using the standard Arcsin transformation for comparing differences in percentile ranking, there is an effect size of 0.67 sd in favour of the experimental group ($t = 2.63$, $p < .05$).

Gains of a similar magnitude are reported for the pre- to post-test gains on the second administration of Raven's matrices (Table 11). The mean difference between the gains in total score this time were 0.94 standard deviations in favour of the experimental subjects ($t = 5.07$, $p < .001$), and 0.73 sd for the changes in percentile ranking ($t = 4.82$, $p < .001$).

The data at first sight appear to suggest that there is some support for Feuerstein et al.'s (1981A) interpretation of 'modifiability' since not only do the IE group significantly improve on their pre-test unassisted performances in relation to the controls but they also seem to respond more to mediation on the LPAD Variations. A closer inspection of the results reveals a different picture.

Firstly, when looking at the 'modifiability' estimates made at both pre- and post-test we find that the changes in estimates do not occur in a regular or predictable fashion for either group. These have been reported side by side in Table 12. The criteria for establishing the estimates of low, medium and high starts and low medium and high 'modifiability' are outlined in Chapter 4 (Table 8, page 165).

In Table 12 there are instances of changes in 'modifiability' which seem to support Feuerstein's prediction that both the initial starting point and the 'modifiability' will increase for individuals exposed to IE, for example Paul, Terry and Martin. However, there are also instances which support the alternative hypothesis, that is that the initial starting point will have increased but there will now be less response to mediation than on the pre-test, for example Neil and Craig.

Table 12 : Pre- and post-test estimates of 'modifiability', using Raven's matrices

	PRE-TEST		POST-TEST	
	Initial score	'modifiability'	Initial score	'modifiability'
Exp.				
Philip	Low	Medium	Medium	Medium
Neil	Low	High	High	Medium
Paul	Low	Low	Medium	Medium
Craig	Medium	High	High	Low
Terry	Medium	Medium	High	High
Martin	Low	Low	High	Medium
Control				
Sean	Medium	Medium	High	Medium
Jason	Medium	Low	Medium	Medium
Michael	High	Medium	High	Low
Pamela	Medium	High	Medium	Medium
Alan	Medium	High	High	Medium
Marc	High	Low	Medium	Low

The initial score refers to the unassisted administration of Raven's matrices.

'Modifiability' refers to the amount of gain on the second administration of Raven's as a result of intervention on the LPAD Variations.

The post-test gains made on Raven's matrices do not appear to be related to the pre-test examinations of the ability to change: Martin was originally characterised as low starting and having low 'modifiability', and was not expected to profit much from IE, yet he improved his pre-test unassisted Raven's score by 16 questions on a 60 item test (Table 11). Further he improved by 19 on the second administration, more than on the pre-test, in response to mediation on the LPAD Variations. Craig made the greatest improvement on his unassisted pre-test score, 21 questions, although he did not fulfil the pre-test prediction of high 'modifiability' in Feuerstein et al's (1981A) understanding of the term. The two experimental subjects who appear to have gained most on the unassisted administration of Raven's matrices - Martin and Craig - had the lowest and highest pre-test estimates of 'modifiability' respectively.

Furthermore, the changes in estimates for the control group cannot convincingly be distinguished from the patterns of change in the experimental group, see Table 12. For example, Alan has improved on his starting point but decreased his 'modifiability' whilst Jason has improved on his pre-test estimate of 'modifiability'.

In Chapter 4 it was pointed out that both Terry (experimental) and Sean (control) obtained the same pre-test scores on the first and second administration of Raven's matrices. It was thought that the changes in their subsequent 'modifiability' would tell us something about the effects of IE. On the post-test they both started from approximately the same position, 32 and 31 questions respectively, and Terry went ont to score 45 on the 2nd administrations whilst Sean scores 39 (Appendix 6, Table 1). It has already been noted, however, that the increases and decreases in pre- to post-test 'modifiability' estimates are not 'stable' for either group (Table

12). Unfortunately, therefore, Terry's increase in 'modifiability' cannot be interpreted as a defining characteristic of the IE group.

In order to test whether these changes in 'modifiability' are significantly different for individuals in the experimental and control groups, it is necessary to compare their pre- and post-test estimates of the 'zone of proximal development'; that is, the way the subjects respond to mediation on the pre-test (as measured by the gain in total score from first to second administration of Raven's matrices) compared with the way they respond to it one year later. In this study there is <u>no</u> difference between the pre- to post-test <u>changes</u> in 'modifiability' of the two groups (t = 0).

In Chapter 5 it was stated that the experimental group increased their pre-test mental age scores on Raven's matrices (unassisted) by an average of 22.8 months compared with 11.2 months for the controls. The experimental group have certainly been 'modified'. However, despite these impressive differences, the findings cannot be interpreted as support for either prediction concerning the effects of IE: the 'modifiability' of the experimental group has neither increased nor decreased in relation to that of the controls. The pre-test estimates of 'modifiability' cannot therefore be used as a valid predictor of the effects of the experimental programme.

<u>POST-TEST RESULTS OF THE LPAD VARIATIONS</u>

The correction of impaired cognitive functions is an important part of the 'modifiability' process. Since these functions are observed from individual performances on the Variations, the post-test results show the extent of the remediation for the experimental group as compared to the changes that have occurred for the control group. A second indication of 'modifiability' can be obtained by comparing the pre- and post-test records of the amount of assistance offered to the subjects to enable them to solve the items.

The level of examiner intervention for each subject has been recorded in accordance with the mediational-hierarchy (Chapter 2) and the post-test mediation levels per question can be found in Appendix 6 (Table 2). Although both groups need less help to solve the post-test items than they had done previously, the experimental group again made the greatest improvements. When the mean 'losses' were compared there was a difference of 0.60 sd in favour of the experimental group ($t = 1.04$). See Appendix 4C, Table 2 and Appendix 6, Table 2, for the raw data on the LPAD mediation scores for the pre- and post-tests respectively.

Greater emphasis has been placed on the effect size, in sd units, than the statistical significance of the differences between the gains of the two groups for the tests in the LPAD battery. Since there is no data on test-reliability for these tests we can only use the sample standard deviations as they stand in order to arrive at the standard error term. For tests in the psychometric and achievement battery the 't' value can be made more sensitive by including the reliability of the test as a factor in the measured pre- to post-test change. There is therefore less chance of making type 2 errors, that is rejecting significant differences (Chapter 5). Without this information the power of 't' is much reduced. An effect size of 0.5 sd is considered to be a meaningful difference. This emphasis will be further justified in the section on changes in the use of cognitive functions ('Cognitive deficiencies').

Aspects of performance

When analysing the pre-test data (Chapter 4) it was decided that individual patterns of responding (poor, adequate or good) would be reported in relation to three major aspects of performance:

(1) Egocentric communication and the quality of the verbal response;

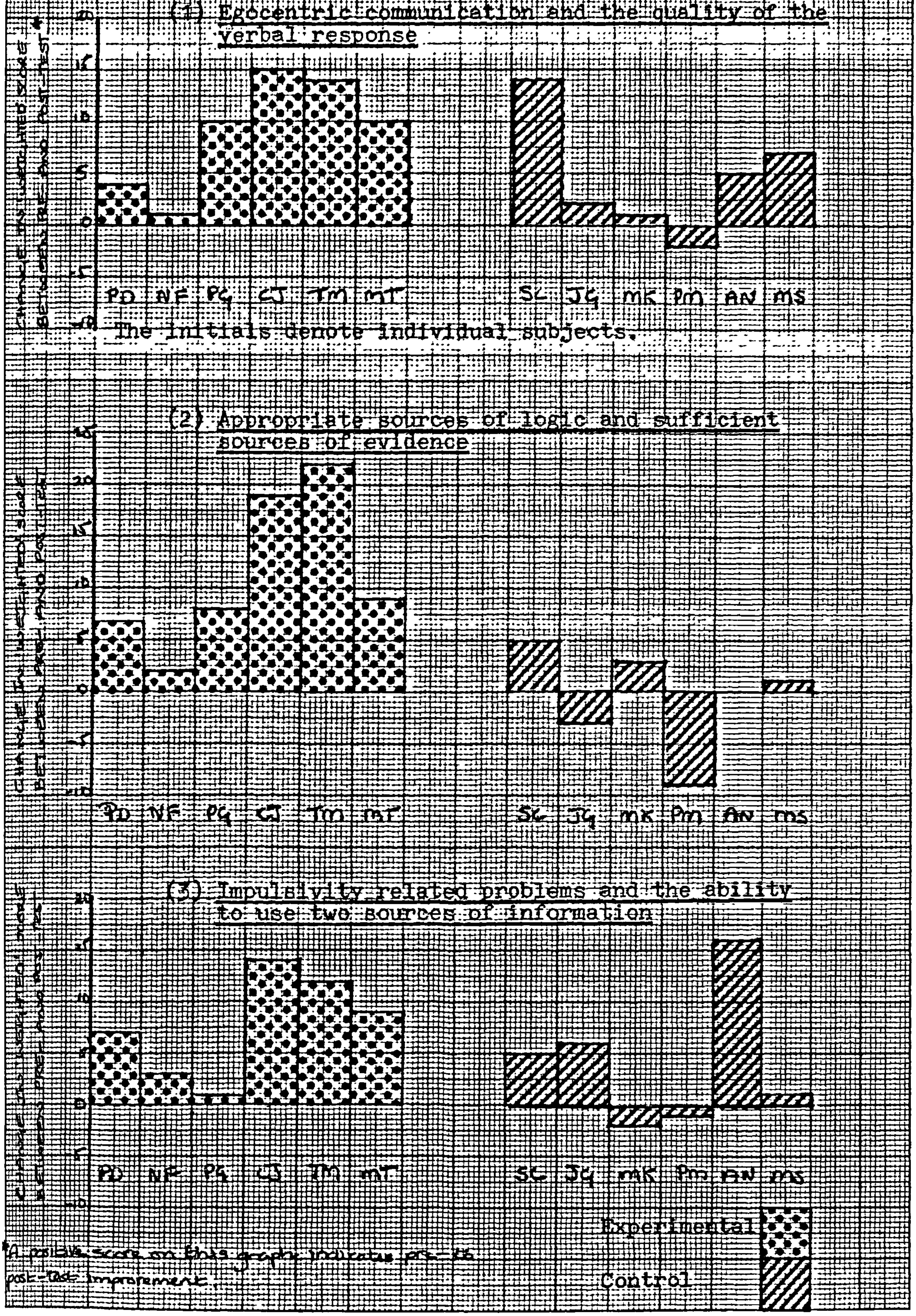
(2) Appropriate sources of logic and sufficient sources of evidence to support an answer; and

(3) Impulsivity related problems which may occur with or without the ability to use the sources of information when solving matrix problems. The same criteria have been used on the post-test results of the LPAD Variations and the results are reported in Appendix 6 (Table 3).

Figure 15 (1, 2 and 3) shows the experimental and control subjects' improvements in relation to the three aspects of performance on the LPAD Variations. These differences are obtained by comparing the 'weighted' pre-test scores with those of the post-test (Appendix 4C, Table 3 and Appendix 6, Table 3). In fact pre- to post-test improvement is indicated by a negative difference (post- minus pre-test) because the higher the 'weighted' score the worse the performance. In Figure 15, however, improvements or a loss in 'weighted' score, are represented in a positive fashion so that they are more obvious. Where negative results arise this means that the subject's performance has deteriorated.

The change in 'weighted' score for each subject on each aspect of performance has been plotted in Appendix 6 (Figure 1) to give an indication of the individual variations. The gains for the experimental group appear to be more consistent than they are for the control group: they may be modest, as in Neil's case, or substantial as in Craig's, although some experimental subjects have developed one aspect of performance to a greater extent than another, for instance

Figure 15: The experimental and control groups' improvement on the LPAD Variations with reference to three aspects of performance:



Paul or Terry. Some individuals in the control group have also improved but these gains seem to be less consistent across all three aspects of performance (see Figure 1, Appendix 6).

By comparing Figure 1 (Appendix 6) with Figure 11 (Page 170) one can look at the post-test improvements in relation to the individuals' pre-test starting point. The relationship between the pre- and post-test results is not strong. For example, Martin, an experimental subject, who gave one of the poorest pre-test performances made consistent gains on all three aspects of performance. On the other hand, Michael (control) gave one of the best pre-test performances but his post-test improvements are negligible and Pamela, also a control subject, made losses on all three aspects of performance. Philip and Craig, (experimental subjects), differed considerably in their post-test gains in 'weighted' scores despite being roughly matched on the basis of the pre-test results. IE has positively affected each subject in the experimental group to a greater or lesser degree but the 'extent' cannot be predicted by their pre-test ability status.

However, the pre- to post-test improvements are greater for the experimental group than for the control, particularly for the Logic/Sufficient evidence aspect of performance (see Figure 15:2). The difference between the gains of the two groups on this aspect was 1.91 standard deviations ($t = 3.06$). On the Egocentric communication/Language aspect the difference was 0.88 sd ($t = 1.49$) and for Impulsivity/Two sources of information the difference was 0.51 sd ($t = 1.03$).

If 0.5 sd is accepted as the criterion for a meaningful effect size then the evidence suggests that IE can fulfil its promise to address and remedy deficient cognitive functioning.

Cognitive 'deficiencies' (LPAD Variations)

It was originally hoped that there might be some way of relating improvements in cognitive functioning to the individual characteristics of the subjects. Although access was granted to the personal files of the subjects, the reasons for their referral to a special education school could not be 'translated' into the language of the Phase parameter of Feuerstein's cognitive model. Instead, both experimental and control subjects tended to be referred on the basis of poor reading ability, anxiety and lack of progress within the regular school framework. The pre- to post-test improvements in observed cognitive 'deficiencies' have therefore been contrasted for the experimental and control subjects on a group basis.

The post-test raw scores of the frequency of occurrence of 'deficient' cognitive functioning on the LPAD Variations is reported in Appendix 6 (Table 4A.) When calculating the difference between these and the pre-test results, the improvements have all been reported in a positive direction. If the number of observations of cognitive impairment has decreased from pre- to post-test then this represents an improvement. For six of the cognitive functions there is already positive coding of responses, that is where the subject has done well, the functions being two sources of information, hypothetical thinking, use of logic, labels, sufficient evidence and language. Improvement here is represented by an increase in the frequency of positive observations. Where more than one type of observation can be made (the last three of the above list), the responses have been weighted before change could be estimated: a good response received a weighting of two points and an adequate response received one point. The pre- post improvements on each of the cognitive functions have been recorded in Appendix 6 (Table 4B)

Table 13 :

Pre- to post-test changes in the observed frequency of 'deficient' cognitive functions for the experimental group compared with the control group on the LPAD Variations.

Cognitive deficiencies	Level of 't'	(p.)	Effect size (sd's)*	Difference between the pre- and post-test means: Experimental	Control
Labels	1.02	ns	0.76	(5.17)	(-0.67)
Problem definition	no instances observed on pre- or post-test				
Relevant cues	0	ns	0	(-0.67)	(-0.67)
Impulsivity	1.25	ns	0.89	(0.83)	(-0.83)
Trial and error	1.31	ns	0.90	(-0.33)	(-1.17)
Blocking	-0.26	ns	-0.21	(-1.17)	(-0.67)
2 sources of inform.	0.90	ns	0.45	(4.00)	(2.50)
Hypoth. thinking	1.50	.20	0.60	(2.43)	(1.17)
Interioriz-ation	2.09	.10	1.29	(1.50)	(0.00)
Episodic grasp of reality	0.85	ns	0.76	(0.33)	(-0.50)
Logic	2.42	.05	1.53	(4.83)	(0.17)
Egocentric communicat.	0.18	ns	0.14	(1.50)	(1.33)
Sufficient evidence	3.39	.01	1.80	(10.67)	(0.83)
Language	0.55	ns	0.41	(8.17)	(5.83)

*Effect size refers to the 'mean difference', in terms of standard deviations, between the pre- to post-test changes in the two sample means.

for individuals in the experimental and control groups.

The experimental group have generally shown less evidence of 'deficient' cognitive functioning and these improvements are of a greater magnitude than for the control group. Table 13 reports the significance of the differences between the improvements of the two groups, (t is two-tailed with 10 df). The pre- and post-test means have also been reported.

Because of the small sample size there is a great danger of making a type 2 error in rejecting effect sizes whose magnitude, if statistically significant, would be considered substantial. Therefore, in view of the fact that only two of the differences in the cognitive 'deficiencies' are significant in terms of individual comparisons, it is necessary to consider the battery as a whole as a guide to interpreting the effect sizes shown in Table 13. The 13 observations on six subjects were treated as 78 observations on the experimental group, likewise for the control. (Raw data from Appendix 6, Table 4B). This gave the experimental group a mean of 2.962 (sd = 5.28) and the control mean of 0.6667 (sd = 4.025). The variance ratio for the two samples indicated that the standard deviations were significantly different (Winer 1962, p.34) and therefore a modified degrees of freedom was calculated for the tables of the t-distribution (Winer, p.37). Because we are dealing with difference scores (McNemar, pp. 96-98, 116-117) the squared standard errors of experimental and control groups were added rather than averaged in obtaining the standard error of the differences between the difference scores.

The computation follows:

$$\text{Experimental } SD_{e_D} = \frac{5.28}{\sqrt{78}} = 0.598$$

$$\text{Control } SD_{e_D} = \frac{4.0248}{\sqrt{78}} = 0.456$$

$$SD_{e_{DD}} = \sqrt{.598^2 + .546^2}$$
$$= .752$$

$$t = \frac{2.962 - 0.6667}{.752} = \underline{3.05} \quad (df = 82) \quad (p < 0.005)$$

Given that the 13 effect sizes, taken as a battery, show a highly significant difference between the experimental and the control group (0.72 sd on average), the effect sizes for the individual cognitive 'deficiencies' can now be given a more unitary interpretation. The question should be: Can they be considered as small-sample variations around a common mean difference effect size of 0.72 standard deviations? To test this both Scheffé and the more powerful Newman-Keuls test were used to see if either the largest or the smallest reported mean differences can be considered significantly different from the others in the battery. The statistical procedures undertaken are reported in Appendix 7 (1). Both tests suggest that all the mean differences should be considered as variations around a common mean, and thus that the sub-test mean differences should be simply averaged to obtain an estimate of the experimental/control mean differences which have already been shown to be significantly different.

In order therefore to avoid making a type 2 error we ought to treat all the effect size estimates as crude but real approximations to something in the order of 0.72 sd whilst being uncertain as to which of the cognitive deficiencies are giving the most reliable signals.

The experimental group have shown more remediation of their 'deficient' cognitive functions than the control group. In Table 13 the only function where a difference in favour of the control group was reported - in fact it was a case where both groups deteriorated but the control group deteriorated less than the experimental group - was both statistically negligible and well below the 0.5 sd mean difference which indicates a meaningful change (0.21). Statistical procedures (Scheffé and Newman-Keuls) indicate that the effect size should be interpreted as approximations of a common mean difference, 0.72 standard deviations, in favour of the experimental group. Moreover the pre- to post-test reliability of these measures of the cognitive functions has actually increased for the experimental group whilst remaining constant for the control group. This increase in consistency for experimental subjects is a strong argument for the overall effect of IE (see below).

The reliability of the LPAD Variations test

Thirteen cognitive functions are observed by the administrator during the clinical interview on the LPAD Variations: some in the form of errors, or deficient functions; others in the form of adequate use of the function. (This excludes problem definition where no observations were made on either pre- or post-test). Thus the observation of the Phase part of the LPAD model can be regarded as a 13 sub-test battery and one may investigate the reliability both in terms of internal consistency and of test-retest.

The internal consistency can be computed by analysis of variance (Winer, pp.126-130). For the pre-test measure, the experimental and control results were pooled and the reliability obtained was 0.67. For the post-test results separate estimates were calculated for the two groups since one might expect that IE has influenced the experimental groups' use of cognitive functions. The reliability for the experimental group was 0.88 compared with 0.65 for the control group. These differences are sufficiently large to merit further investigation. The ANOVA calculations are reported in Appendix 7 (2).

It can be seen that there is clearly no difference, as indeed there should not be, between the pre- and post-test reliability for the control group. The test-retest reliability for this group can easily be calculated as the correlation between the pre- and post-test scores, which was 0.57, and of the same order as the internal consistency estimates. The difference between the pre- and post-test reliability for the experimental group, however, is over 4 standard errors, tested by Fisher's z at (60 minus 3) degrees of freedom, and can therefore be treated as a real difference.

How can this difference be explained? Remembering that the purpose of using the LPAD form of testing was to discover whether the effect of IE instruction would show up in terms of the Phase parameter of the LPAD model, the reliability which is really of interest is that of the <u>difference</u> scores: that is, the measures of pre- to post-test improvement for each group. The calculation is reported in Appendix 7(3). The reliability for the difference scores is 0.73 for the experimental group. The test-retest correlation was only 0.33. The corresponding reliability of <u>difference</u> scores for the control group was only 0.24 (see Appendix 7(3)).

A reliability of difference scores of 0.73 is a very respectable value: the drop shown from 0.67 to 0.24 for the control group is of the order of a low reliability of difference scores to be expected. The meaning of the high post-test reliability of the experimental group is that the inter-correlation between the sub-tests has increased substantially. This is precisely one of the things that IE directly sets out to do. The cognitive functions are openly part of the transactions between the teacher and the pupil in every lesson: pupils are meant to bring several to bear on each new lesson unit. It is therefore to be expected that not only would the experimental group show a higher post-test score than the control group, but they would also be more consistent in their behaviours as observed through the different functions. There is direct evidence in this study that this is indeed the case. The experimental group have not only shown more improvements in their use of cognitive functions than the controls, but also the correlation between the different parts of their behaviour has also increased.

THE REPRESENTATIONAL STENCIL DESIGN TEST

The lack of test reliability information for the RSDT resulted in many problems for the analysis of the pre-test data (Chapter 4). Since there are no external norms of reference which can be adapted for use with this test, RSDT has proved less fruitful as a test of 'modifiability' than originally anticipated.

In order to get a measure of 'modifiability' from the RSDT data a technique was introduced which in effect determined the individual's 'zone of proximal development'. That is, the difference in the number of items on which the subject could succeed was calculated when moderate and substantial intervention was offered. The details are provided in Chapter 4. The post-test estimates of 'modifiability' have been calculated in the same way and are reported in Appendix 6 (Table 5).

In terms of the number of items completed before any assistance became necessary, no difference was observed between the amount of pre- to post-test improvement made by both groups ($t = 0.46$, with 0.16 sd difference between the means). As one of the control subjects completed the test without requiring even minimal help, comparisons could not be made on a group basis about the differences in the number of items successfully completed with moderate or substantial help (because of the 'ceiling' effect).

In view of the fact that the Raven's pre-test estimates of 'modifiability' proved unreliable predictors of post-test performance, little store was set by the RSDT estimates. Indeed the two show little agreement (for the Raven's estimates refer to Table 12). Once again there is a pattern of inconsistency with the 'modifiability' estimates of experimental subjects either increasing or decreasing after IE intervention. There seems to be nothing by which to distinguish the improvements made by experimental subjects from those made by the controls (Appendix 6, Table 6). The post-test mediation scores per item for individuals in both groups can also be found in Appendix 6 (Table 7).

Cognitive 'deficiencies' (RSDT)

As all the subjects were already near the 'ceiling' on the pre-test RSDT training page it was not thought profitable, at that time, to analyse the results in terms of observed cognitive 'deficiencies'. For the same reason the differences between the use of these cognitive functions by the two groups have not been calculated for the post-test training page results. The raw data can be found in Appendix 6 (Table 8).

A further problem noted on the pre-test was that, since the subjects did not all complete the same number of items on the RSDT test page, the frequency of observed cognitive 'deficiencies' could not be compared across subjects. On the post-test, however, one can compare the improvements made by each subject, that is, a reduction in the number of 'deficiencies' observed. If a subject has attempted a greater number of items on the post-test than he had attempted previously, then the two performances can only be compared up to the same 'cut-off' point on the test. The raw data for the frequency of observed 'deficient' cognitive functions on the test page can be found in Appendix 6 (Table 9); for 'deficiencies' observed on items that were not attempted on the pre-test, the frequency has been recorded additionally (+) in this table.

Table 14 reports the effect sizes of the pre- to post-test changes in the use of cognitive functions by the two groups (t is two-tailed with 10 df). On this test only one post-test mean was lower than the pre-test mean; the experimental group showed more evidence of 'blocking' than they had done previously. The same thing also happened on the LPAD Variations. Although the analysis of results on the latter test indicated that the cognitive functions should be looked at collectively the fact that there was an increase in 'blocking' behaviour on both tests suggests it may be worthy of further investigation. A tentative explanation is that as IE deliberately encourages the students not to make impulsive decisions in situations of uncertainty, they may react by 'blocking' rather than rushing to find the answer.

Table 14 :

Pre- to post-test changes in the observed frequency of 'deficient' cognitive functions for the experimental group compared with the control group on RSDT.

Cognitive deficiencies	Level of 't'	(p.)	Effect size (sd's)*
Problem definition	no instances observed on pre- or post-test.		
Relevant cues	0.40	ns	0.34
Impulsivity	0.77	ns	0.47
Blurred perception	0.39	ns	0.36
Precision & accuracy	0.16	ns	0.06
Attention to sequence	-1.04	ns	-0.49
Trial and error	1.75	.20	1.43
Blocking	-1.35	ns	-0.89
Hypothetical thinking	-0.82	ns	-0.48
Interioriz-ation	-0.92	ns	-0.81
Episodic grasp of reality	-0.22	ns	-0.18
Visual transport	0	ns	0

*Effect size refers to the 'mean difference', in terms of standard deviations, between the pre- to post-test changes in the two sample means.

A negative difference means that the control group showed the greatest improvements.

There is no plausible explanation as to why the control group have made greater improvements than the experimental group on some of the cognitive functions. Moreover, the 1.43 sd effect size in favour of the experimental group is not thought to reflect a genuine difference in 'trial and error' behaviour: no instances of this deficiency were observed on the post-test for either group or on the pre-test for the control group. The control group therefore had no room for improvement and the large effect size is hence a consequence of the lack of variance in the pre- and post-test sample means. Nevertheless, the experimental group did improve in their use of this function.

The RSDT was adopted as the second form of LPAD testing at the suggestion of Feuerstein himself. From the list outlined in Table 4 (page 122), this was the only other test which highlighted a variety of cognitive functions and where there was also considerable opportunity for examiner intervention. A further stipulation was that it should not occur as an instrument in the IE programme for these subjects.

The effect sizes for improvements in RSDT are generally much lower than those obtained on the Variations. RSDT can be taught as a third year instrument and there might be a good reason for leaving it until this point. The skills demanded by this representational task may be of a much higher order than those taught to the experimental subjects in the first eighteen months of the IE programme, whereas the skills involved in successful performance on the LPAD Variations are probably more akin to those developed in the early stages of IE instruction; for example, the emphasis on language as a tool to aid thought by labelling objects or by providing reasons in support of one's answer and so on.

This underscores the need for information on task complexity because there is a suggestion here that 'deficient' patterns of cognitive functioning may be more closely related to the difficulty of the task rather than individual characteristics of impaired performance. Details of task complexity would be needed to investigate this suggestion. This would also enable one to directly compare a child's performance in tasks representing the different modalities which is another of the aims of LPAD testing.

DISCUSSION

The results of the Representational Stencil Design Test have been disappointing, however, the results of the other tests in the LPAD battery are extremely interesting. Whilst there is no evidence to suggest that the 'modifiability' estimates have changed for the experimental group, in either direction, there is considerable evidence to suggest that modification has occurred. Using Raven's (1981) norms to provide a standardised measure of change, there are greater improvements for the experimental group in terms of total score, mental age and percentile ranking. There is also strong evidence that the performances of the experimental group have improved significantly, in relation to those of the control group, both in terms of cognitive functioning and in the amount of assistance they required on the LPAD Variations.

The LPAD Variations have been used to monitor the pre- to post-test changes in the experimental and control groups' use of the cognitive functions described by the Phase parameter of Feuerstein's cognitive model. In all but one case the differences were in favour of the experimental group. Although some of the differences between the two groups were very large, we are advised to interpret them only as fluctuations around a common mean difference of 0.72 sd of <u>all</u> the cognitive functions. In addition to this, there has also been a substantial post-test increase in the correlation between the different parts of the test (the cognitive functions) for the experimental group. Both of these findings certainly suggest that IE is affecting the areas of impaired performance for which it was designed.

The results seem paradoxical. On the one hand there are no constant pre- to post-test changes in the 'zone of proximal development' for members of the experimental group, nor are there any reliable pre-test predictors of 'modifiability'. Yet, on the other hand, the increase on measures of "fluid" intelligence for the experimental group (Chapter 5) indicates that their ability to be 'modified' by fresh learning experience <u>has</u> increased as Feuerstein would expect.

The improvements of the experimental group on measures of the Phase parameter, and the increase in reliability of these measures, suggests that these individuals have undoubtedly increased their ability to <u>assimilate</u> reality as demonstrated by the improvements, over and above those of the control group, on the LPAD Variations and on Raven's matrices. However, the greater <u>adaptability</u> of the experimental group suggested by the increase in "fluid" measures, coupled with the improvements witnessed in their use of the cognitive functions, have <u>not</u> been expressed on tests of "crystallised" intelligence, on measures of school achievement or in terms of an increase in their 'zone of proximal development'. The paradox remains. Further empirical work is recommended before we can with confidence either accept or reject the notion that IE increases the 'modifiability' of individuals exposed to it.

CHAPTER 7

IS IE AN EFFECTIVE MODEL FOR INTERVENTION?

SYNTHESIS OF RESEARCH FINDINGS

The present results suggest that the underlying ability of this small experimental group to process reality has been substantially affected by IE. The average change in the Piagetian level of functioning of the experimental group, when expressed in mental age terms, is slightly higher than would be expected for a group of this age range at the 50th percentile. On Raven's matrices the average gain in mental age was 22.8 months for these subjects compared with 11.2 months for the controls. Moreover, the actual pre- to post-test time span on the Raven's matrices was only 12 months. On both of these tests, which can be described under Cattell's (1971) classification of "fluid" intelligence, there have been dramatic improvements for those subjects who received IE. A second major finding of this study has been the impressive change in the use of the cognitive functions by the experimental group, as measured on the LPAD Variations. To date, no other study has focussed upon this aspect (Phase) of Feuerstein's cognitive model.

These impressive changes, however, have not been expressed on tests of "crystallised" intelligence or on measures of school achievement. A larger effect size was obtained on the Richmond basic skills test than on other school achievement measures (Table 10, page 179) and one could argue that this test has a slightly higher "fluid" component.

The data from previous studies can now be examined retrospectively to see how closely their findings fit in with the present interpretation: that is, whether or not the most important effect sizes are reported on measures of "fluid" intelligence. (Refer to Tables 2 and 3, page 72 and page 76 respectively for the Israeli and American findings).

No data on the Piagetian level of functioning is available for either of these samples but other measures of "fluid" intelligence have been used. The Israeli team have reported their largest effect size on a test of embedded figures (1.0 sd) and the Americans have also reported positive findings on Raven's matrices and on parts of other psychometric tests which have a large "fluid" component, for instance the Lorge-Thorndike and Woodcock-Johnson non-verbal IQ tests. One extremely interesting finding for a two year study in Arizona has been a massive 1.63 sd differential between the experimental and control groups' measures on Raven's matrices (Haywood et al. 1982).

As noted in the literature review (Part 2) the interpretation of the American data has been complicated by a number of factors: for instance, different project sites have used different types of sample, and the types of test used have not always been consistent across different project sites or even for different year cohorts within a site. The picture is further clouded because some of the non-significant data has not been fully reported and this necessarily biases the overview of the results.

Both teams found evidence of improved "crystallised" ability in their IE samples, as measured by the Thurstone PMA, although these findings have not been reported for all sub-tests or all year cohorts in the American data. For the Israeli sample, the differences between the groups were statistically significant on four of the sub-tests but overall (total score) the effect size was a modest 0.35 standard deviations, even after a two year intervention programme. It must be remembered that in this case the control group was also enriched.

In terms of achievement measures, none of the three studies - the present, the Israeli or the American - report systematic differences between the experimental and control groups. The differences which emerged on the CTBS academic achievement tests for the Nashville sample (1980-81) unfortunately were not maintained in the second year of the programme, (although 1981-82 was beset by administrative difficulties for the evaluators, Haywood et al. 1982).

The School's Council report on the IE experience in five LEA's in Britain (Weller & Craft 1983) has contributed little to the formal evaluation of the effects of IE on the pupils receiving it. The only pre- and post-test to be administered was the Young Oral verbal intelligence test and even here the results have not been reported. Since there were no structured observations of lessons by the various evaluators it is difficult to determine the impact of IE.

Where evaluation of the effects of IE has been undertaken the results agree to the extent that on all three studies the largest effect sizes appear on measures of "fluid" intelligence whilst nothing of importance emerges on tests of achievement. Thus, despite the fact that no systematic increases in 'modifiability' estimates have been observed for IE subjects in the present study, their improvements on measures of "fluid" intelligence suggest that their underlying ability to process reality has increased. How is it then, that this presumed increase in ability has not been indicated by parallel improvements in school achievement in any of the IE samples? In answering this question it is necessary to ask another: What kind of school achievement should we have been testing?

WHAT KIND OF ACHIEVEMENT SHOULD WE MEASURE?

Other researchers have commented that standardised tests fail to pick up changes in IE pupils which are observed by their teachers (Arbitman-Smith & Haywood 1980). This has prompted the Vanderbilt team, principally Ruth Arbitman-Smith, to look for ways of assessing IE which are more closely related to the nature of the IE materials. In addition, measures of drive, persistance, self-perception, motivation and conduct in the classroom have been looked at by the American and Israeli workers. Whilst these measures may be important when dealing with low-functioning or disturbed children, the 'academic' issue is too important to be side-stepped.

In this study it is maintained that 'academic' support is vital if IE is not to go the way of some other intervention programmes. However, the lack of this support to date may be because we have all, unavoidably, been testing the wrong aspect of achievement. It is suggested here (with hindsight) that the real test of IE would be to look at the individual's ability to process <u>fresh</u> material <u>after</u> the IE course has been completed. In other words we should be looking at the subsequent learning of IE subjects in relation to a control group.

The argument is as follows. Tests of achievement cover learning which may have occurred in the previous 3 to 4 years for the individual. Improvements which occurred over the last year as a result of intervention may, even if dramatic, only be a small percentage of the whole field of skills which is being tested. Newly developed skills may not therefore make much impact on standardised tests of achievement.

If one now arranges to test only the learning that has occurred <u>after</u> the pupils have been affected by IE, that is, fresh learning, in any subject area (geography, mathematics and so on), then one has a measure of their ability to process reality which is not diluted by past experience. It is in the areas of new learning where we might expect the differences between experimental and control subjects to show up.

The follow-up to the post-test results from the Israeli study lend support to this suggestion (Feuerstein et al 1981A). After a two year intervention programme, the mean difference between the experimental and control groups was only about 0.35 standard deviations on Thurstone's PMA. However, after 18 months, with no further training, the difference had opened up to 0.85 sd when both groups were tested as part of the army induction process. This suggests that irreversible effects had occurred, such that the IE pupils were now able to interact with the world in a way which was more favourable to their continuing cognitive development than the control group.

From a pedagogical point of view the suggestion is that if one's aim is to effect changes in the kinds of skills required for school achievement tests, then the period after IE intervention is the point at which one should arrange for these skills to be 're-processed'. The previous curriculum can then be covered again but at a much higher level of functioning, and at a much greater speed. IE can influence the subject's learning history 'retrospectively' so that his increased ability will not only show up on those skills acquired during the intervention programme but also on the skills learnt prior to it, which form a substantial part of the achievement test.

Assuming these curriculum experiences are shared by the experimental and control groups, one would now expect the achievements of the former IE subjects to be of greater magnitude. This has not yet been tested empirically. If, however, this does prove to be the case, then it is not surprising that current IE research, including this study, has not found support for the programme in terms of school achievement. We may have been looking in the wrong direction. Feuerstein's claim that IE increases pupils' adaptability cannot therefore be dismissed.

IS THE COGNITIVE MAP A VALID HEURISTIC FOR THE CONSTRUCTION OF THE IE MATERIALS?

Operations

In this study a dramatic improvement was recorded in the Piagetian level of operational functioning for subjects in the IE group. Indeed, the difference between their improvements and those of the controls was of the order of 1.22 sd. Attention has already been drawn to the fact that this massive increase was not accompanied by parallel improvements in school achievement and a reason has been suggested (above) as to why this might be so.

Modality

In terms of the modalities (as measured by the sub-tests of Thurstone's PMA) it has to be admitted that the present results can not be used in support of positive changes in these areas of functioning. The Israeli team found significant differences between the experimental and control groups on four of the sub-tests but the effect size for the total score was a modest 0.35 standard deviations however, as already mentioned, this difference between the groups increases to 0.85 sd, instead of diminishing as might have been expected, when the subjects were tested 18 months later. The American data also consistently suggests positive changes on some parts of the PMA, (across different project sites and with different year cohorts).

In view of their findings, where larger sample sizes have been involved, it seems reasonable to use this parameter in designing a variety of IE instruments, but to use tests of it over a longer time period.

Phase

Thirdly, in terms of the Phase parameter, there is strong support from the present investigation for the argument that IE has improved the experimental group's use of the cognitive functions described by Feuerstein. This was indicated by an increase in reliability for the post-test measures of these functions (on the LPAD Variations) for the experimental group where none was apparent for the control group. In other words, on the post-test the correlation between the different parts of the test, that is the cognitive functions, increased for the experimental subjects, (see Chapter 6). Since one would expect the experimental group to become more consistent in their use of cognitive functions the reported increase in reliability is a crucial piece of evidence in support of Feuerstein's model.

Of the four parameters that have been omitted, 'content' is fixed by the nature of the task materials and the levels of 'complexity', 'abstraction' and 'efficiency' do not have operational definitions, (see the literature review Part 2). They have not therefore been included in this study or in any other.

The work reported here suggets that the model of intervention can be validated with respect to at least three parameters of the cognitive map, two of which ('operations' and 'phase') have hitherto not featured in any IE research. The present findings, coupled with those of others, also indicate that IE works for the reasons suggested in the model. The model must therefore be a valid tool for the construction of the IE instruments.

FUTURE WORK ON IE

If IE is to be adopted as part of the regular curriculum for low-attaining adolescents, then it must be shown that the increase in the pupils' ability to process reality can be translated into areas related to the common goals of education. One reason has already been suggested why these effects have not so far been forthcoming. Nevertheless, one would wish to draw attention to the non-effect observed since part of the IE method, that process called 'bridging', would predict an effect even after two years, but whereas the rest of the IE process is well described in the excellent teacher's guides, bridging is essentially left to intuition.

Bridging refers to that part of every IE lesson where the teacher and pupil are encouraged to link what has been learnt in the lesson to other contexts. The process is crucial. The learning opportunities will evaporate if pupils fail to see how the skills acquired in the IE classroom can be used to solve 'real' problems.

IE has not been equally successful with all pupils, with all teachers or in all situations. A major factor, in the experience of the Americans and also in the five LEA's in this country, contributing to these differences was the amount of bridging which occurred in the IE lessons, (Haywood et al 1982, Weller & Craft 1983). The two major limitations to this process are reported to be too few timetabled lessons or the lessons being given by a teacher who was not the regular class teacher. Both of these problems were caused by the kinds of timetabling and administrative difficulties which face any new curriculum initiative.

According to the School's Council report, bridging is the most difficult aspect of the lesson to accomplish and it was frequently mentioned by the teachers as a source of difficulty (Weller & Craft 1983). It is interesting to note that only 50 percent of the pupils in this study could positively say that the IE work helped them with other lessons. This suggests that the other 50 percent perceived IE as being isolated from the regular school curriculum. Moreover, there is a possibility that the positive scores were inflated since the pupils' evaluation of the programme may be mixed up with their evaluation of the teacher.

The first instrument 'Organisation of Dots' is meant to serve as a model for the teacher to acquire the mediational style and 'bridging' ability, and here the material is exemplary. For example, a list of the principles of organisation is provided for.discussion: things may be classified according to their type (fabrics in a laundry, sections in an orchestra, poisonous drugs from non-poisonous ones and so on), their function, frequency of use, size, sequence, order of importance, price, aesthetic appeal, age, weight, common interests and so on, with full illustrations for each. 'Organisation' is itself only one topic from a list of 17 that are recommended for discussion in this instrument. Later on, in 'Analytic Perception', (units 35-38), the only guideline for bridging is the suggestion that a summary sentence should be composed for the main principle of each of the units which should then be reviewed and applied to academic and vocational subjects. This assumes that the mediational style has been internalised.

At a recent AERA conference, however, Kersh et al (1984) claimed that the teachers may experience some difficulty adapting to the role of IE mediator. They found that the self-reports of teachers own perceptions of their IE teaching were not consistent with observational evidence of the same IE classes. That is, the teachers believed themselves to be working towards more of the goals of IE, including bridging, than they actually were. The changes in the way teachers developed mediational strategies were slow and not all of them were in the desired direction. It may not therefore be appropriate to cut down on the explicit bridging examples given in the manuals as the IE course progresses.

At the moment IE is copyrighted and a specific training procedure but the principles could probably be extracted and used in the generation of fresh materials. This is likely to be the way forward for this model of intervention. In view of the fact that bridging is a substantial part of the programme, there is a need for further work to define it more explicitly in the teaching manuals and to provide many more examples. Use of IE depends on very well trained teachers and a support system of advisory staff who are familiar with the theory. Further research should, in addition to monitoring the effects of IE, seek to describe the bridging process as well as the cognitive map and the mediation part of Feuerstein's model as clearly as possible. This is missing in the work of the Jerusalem team but it is necessary if the principles of IE are to contribute to a general philosophy of remedial teaching.

CHAPTER 8

LPAD AS A MODEL OF CLINICAL TESTING

The use of the Learning Potential Assessment Device confirms that a considerable ability to reason exists amongst retarded individuals which would not otherwise be apparent using more conventional testing techniques. This innovative diagnostic approach to the measurement of potential of handicapped performers breaks with half a century of psychometric tradition which focuses only on an individual's 'stable' characteristics. This humane and optimistic testing philosophy which highlights the mutability of intelligence (in response to intended interventions) must surely be welcomed by clinical and educational psychologists. But more than this, the LPAD model also provides a rich language for understanding cognitive impairments which is shared by an intervention methodology (IE).

Nevertheless a considerable amount of work, both theoretical and empirical, is needed before LPAD can be added to the repertoire of the clinician. The testing model appears to be better defined in the literature (Feuerstein 1979, Feuerstein et al 1981B) than is actually the case. In the literature review (Parts 2 and 4), it was noted that the validity of the LPAD approach is threatened by the lack of clarity and redundancy of some parts of the model. We need to know how the parameters of the cognitive map relate to each other and also how they are represented in the testing and training problems. In order to make assessments in terms of the parameters of the cognitive map specific test items need to be graded for their complexity and for the component skills required for successful performance. The problems caused by the lack of information on task complexity, in particular, has been noted in this study as a continual source of difficulty in the analysis of LPAD pre- and post-test data.

The reluctance on the part of the Israeli team to standardise the LPAD procedure is understandable, since LPAD was developed as a reaction to previous standardised tests which grossly underestimated the capabilities of retarded performers and produced negative stereotypes. However, the justification for using a learning potential approach is that it says something about an individual's capacity for change. The assessment approach must therefore be more precise about this aspect of performance. This is recognized in principle by the Israeli team, at least in their suggestions for future development of the LPAD (Feuerstein 1979).

The new examiners' manual (Feuerstein et al 1984) provides an excellent description of the LPAD tests and the methodology, with multiple examples of the kinds of interaction which take place between examiner and examinee and how these should be interpreted. A second positive feature of the manual is the attempt to describe the deficient cognitive functions in terms of the kinds of errors likely to be encountered on the particular test. For example, on Organisation of Dots, one of the input functions is 'clear perception of standard figures and definition of their characteristics' and two output functions are described as 'a need for precision in connecting dots' and 'projection of relationships between dots to form model figures'.

Scoring criteria have also been introduced for the LPAD tests, however, in my opinion, this is one of the weakest parts of the methodology. The final score is still only a reflection of an individual's <u>achievement</u> and not of <u>change</u> as a result of intervention. Yet it is precisely this 'change' or 'modifiability' in which LPAD workers are interested. This is the whole point of using a learning situation in place of a 'static' form of assessment. The use of 'shift' items to indicate a pupil's learning transfer, described in the research chapter by Feuerstein (1979), has not been extended to the LPAD practice in general.

THE CONTRIBUTION OF THIS INVESTIGATION TO THE DEVELOPMENT OF LPAD

In using LPAD as one of the ways in which the effects of IE were monitored in this study, some of the practical problems concerning the mode of clinical testing have had to be tackled. The work done here on LPAD represents only a small part of the battery. No clinician would rely on such a limited assessment as the basis for intervention. It does however show how the methodology can be developed into a fruitful research heuristic. The implication is that with further work these developments could be extended to the whole LPAD battery. It is recognised that in the present investigation some of the richness of the LPAD model has been sacrificed in the interest of 'manageability'.

In the present study only the LPAD Variations (with Raven's matrices) and the Representational Stencil Design Test were used, for the reasons given in Chapter 2. It was necessary to work with a smaller list of cognitive functions than the ones supplied by Feuerstein (1979, 1980) and those chosen had observable behavioural correlates which were meaningful in terms of the above tests. In addition to this, more precise administration and recording procedures were introduced than had hitherto been used by the Israeli workers. (The details are reported in Chapter 2 and in the appropriate Appendices).

The Mediational-Hierarchy

For the first time in LPAD's history a means of quantifying the amount of examiner assistance to the pupil was introduced. Any type of intervention reduces the power of the statement about the individual's learning potential. It is, therefore, important to make a specific note of the amount of intervention. The mediational-hierarchy was drawn up in consultation with Feuerstein. It refers to a sequence of ten stages of help through which the examiner can proceed when a child has difficulty solving the task, (Chapter 2). The level of help reflects the 'severity' of the cognitive impairment.

The use of the mediational-hierarchy as a measure of 'modifiability' has been limited by the lack of data on task complexity. In theory 'modifiability' would be demonstrated when an individual becomes less dependent on the examiner's intervention in order to solve successive problems. However, as the tasks become more difficult the pupil may actually need more assistance even though he has made learning increments.

Nevertheless, as an indicator of change in the IE sample, the pre- and post-test levels of assistance, for the test as a whole, can be compared. In this study both groups required less examiner intervention on the post-test LPAD Variations but the reduction in the amount of help required was greater for the experimental group (0.6 standard deviations in favour of the experimental group, Chapter 6).

The mediational-hierarchy can, in principle, be adapted to any test where intervention can be graded. If future work on the 'complexity' of LPAD tasks is undertaken, then the hierarchy may come to play a greater role in the measurement of 'change' within the test session.

Baseline measures

A second initiative in this study was the use of Raven's norms to provide both a baseline measure of unassisted performance and a means of estimating the potential for change or 'zone of proximal development'. We hoped by contrasting the estimates made at pre- and post-test, to investigate Feuerstein's notion of 'modifiability', that is, that the potential for change increases as a result of IE intervention. The results will be discussed later in terms of LPAD as a research methodology for investigating the effects of IE.

It does seem that it is possible to alter the administration of Raven's matrices, in the spirit of LPAD testing, without sacrificing the opportunity of using the test norms to estimate change (Chapter 2). It is the 'change' score which must be the essence of a 'learning potential' measurement. Without baseline data it is difficult to determine the extent of the individual's 'modifiability'.

LPAD AS A RESEARCH METHODOLOGY (PRESENT STUDY)

Use of LPAD in previous research is extremely limited. Where it has occurred, for example Bachor (1976), it has not been administered in the 'dynamic' style in which it is intended to be given. In Feuerstein's own case, (1979, Chapter 7), his research methodology does not include a study of the cognitive functions even though this is one of the most important aspects of the LPAD model. In the present investigation, LPAD has been given in its dynamic form and account has been taken of the subjects' use of the cognitive functions.

There was some hostility on the part of the Israeli team, (Jerusalem visit 1983), towards the idea of my using LPAD as a yardstick for monitoring the effects of IE. In the event this has proved to be one of the most interesting aspects of this study. The LPAD Variations has been used in pre- and post-test form, to provide a check on the experimental and control groups' 'behaviour', in terms of the Phase parameter of the LPAD model. It transpires that not only have the experimental group shown greater improvement than the control group in their use of the cognitive functions but also that these 'behaviours' have become more consistent than they were on the pre-test. This can be interpreted as a form of validity for the IE programme (Chapter 6).

The LPAD should cover two aspects of performance which traditional tests do not. It should describe a person's strengths and weaknesses in terms of the Phase parameter and also give an indication of 'modifiability'. In theory all seven parameters should be considered in the production and assessment of change (Feuerstein et al 1981B). In practice it is not possible to use LPAD to obtain an independent measure of an individual's performance in terms of 'operations' and of 'modalities'. In the present study these have been investigated independently using a Piagetian test battery and the Thurstone test of Primary Mental Abilities.

The method of estimating an individual's 'modifiability', described in Chapter 2, corresponds to the Vygotskian notion of testing the 'zone of proximal development'. Thus, within the test session it gives an indication of the effects of mediation, in the form of examiner assistance, on the subsequent peformance of the child. The same method, when used as a pre- and post-test, should also indicate the effect of the provision of mediation by the IE teachers, using the IE materials, in changing the 'modifiability' of the subjects.

If the impact of IE is limited to the correction of deficient functions, then one might expect that the effect mediation has on the post-test LPAD session would move towards some limiting value as the functions are corrected or that the 'zone of proximal development' would decrease. If, on the other hand, there is an additional 'multiplier' effect, then the pupils might be assisted now even more by mediation than they were when originally tested or the 'zone of proximal development' would increase.

LPAD as a test of 'modifiability'

The experimental group's increased sophistication in the use of the cognitive functions has been demonstrated (Chapter 6), and, in absolute terms, their performances on Raven's matrices have increased more than those of the control group. To this extent, the results are supportive of Feuerstein's contention that IE increases 'modifiability', in that both imply that the individuals will now have more powerful 'assimilatory' schemata to apply to fresh experience, including areas of academic work. However, no increase in the measured 'zone of proximal development' was observed for experimental subjects. In fact there were no differences in the pre- to post-tests changes in these estimates between the experimental and control groups (Chapter 6). The results therefore fail to support either prediction concerning the effects of mediation, through IE, on the 'modifiability' of pupils receiving it.

Furthermore, the 'zone of proximal development' measurements on the pre-test did not appear to be related in a systematic way to the gains made by the subjects on the post-test or on any other tests used for evaluating the effects of IE. The experimental pupils who had the lowest and highest estimates of 'modifiability' on the pre-test made the biggest improvements on the post-test (Chapter 6).

LPAD appears to make no differential predictions as to the changes in 'modifiability' shown by any of the subjects in this study. Whilst its use does make one believe in the possibility of improved cognition in many pupils, it fails completely to live up to its claimed ability to measure learning potential.

LPAD as a test of 'modification'

Whilst LPAD lacks the power to predict the kinds of changes anticipated as a result of IE, it certainly detects that changes have occurred. The Raven's matrices, which have been used in the study as part of the LPAD battery, suggest a marked increase in "fluid" ability for the IE subjects. In absolute terms, the difference between the improvements of the experimental and control groups was 1.07 standard deviations.

Moreover, as previously mentioned, the experimental group have demonstrated greater gains than the control group with respect to their use of cognitive functions. They also became more consistent in their behaviour, as measured by the cognitive functions, when no such increase in 'reliability' was apparent for the control subjects (Chapter 6). The description of the cognitive functions, the Phase parameter, is unique to Feuerstein's cognitive model. Thus, the LPAD is the only test which can provide a form of internal validity for the effects of IE. This is the first time LPAD has been used in this way.

LPAD as a method of clinical assessment

The internal consistency of the LPAD battery, 0.67, is not large compared with many group norm-referenced tests. However, what it tests is distinctive and one may assert that its reliability is sufficient to make it a useful member of a battery of tests, in which the others estimate a variety of different behaviours The LPAD Variations could be norm-referenced fairly easily by utilising the Raven's norms which form part of its procedures. For research purposes, the technique has already proved valuable in detecting 'modification' amongst the IE pupils in this study.

FUTURE DEVELOPMENT OF LPAD

It has already been noted that the LPAD model is not as well defined as it might be. This lack of clarity prevents us from making full use of the parameters of the LPAD model as a guide to the assessment of low-functioning individuals. The main problem appears to be the absence of information on 'task complexity' and many of the problems mentioned stem from this.

In the present study use of the Representational Stencil Design Test did not prove successful. One difficulty was the lack of test norms which could be adapted for use with this test. It was also suggested that the skills demanded by RSDT might have been more complex than those developed in the first eighteen months of the IE programme. In fact, an instrument based on RSDT is used in the third year of the programme. If item analysis were to be undertaken for both LPAD and IE tasks, it should be possible to 'match' the assessment to the appropriate level of the teaching units. In this way 'ceiling' and 'floor' effects could be avoided when one is attempting to monitor the success of the programme.

Information on 'task complexity' would help to accomplish two of the stated aims of LPAD testing. Firstly, the information could be used to determine the extent of the 'learning-transfer' ('potential' is demonstrated when the individual applies his recently acquired learning, in the test situation, to items which become progressively harder from the one on which help was available); and secondly, it would enable one to compare an individual's performance across different parts of the model, for instance in tasks representing the different modalities. For the latter to be accomplished satisfactorily one needs to be sure that the tasks are equivalent in all respects other than the parameter being investigated.

As part of his Ph.D. thesis Bachor (1976) applied Pascual-Leone's analysis of task demands to RSDT. A principle has therefore already been established and could be extended to other members of the LPAD battery and for IE.

However, it may also be necessary to investigate the possibility that deficient cognitive functions observed on low-level tasks are more significant in terms of the ease of correction , and that some deficiencies may only be observed as a function of the difficulty of the task, that is they are not characteristic of an individual in terms of systematic errors but they come into operation for all individuals when the tasks become extremely complex. This may be true of RSDT (Chapter 6).

Lastly, the creation of test norms for the different tests in the LPAD battery would enable one to make comparisons between the performances of different individuals and the same individual at different points in time.

As shown in this study, the Learning Potential Assessment Device is valuable both as a testing technique and as a research heuristic. Moreover, it seems that standardisation of this procedure can be achieved without sacrificing the spirit of LPAD testing. In Israel, the use of LPAD has been instrumental in returning hundreds of children back into mainstream education (Feuerstein 1979, p.230). With further developments it could become an even more successful tool, in the hands of the skilled clinician, with which to counter the under-assessment of innumerable individuals. Reuven Feuerstein has played a historical role in developing the belief in the potentiality of intervention and, in particular, for individuals who have already reached adolescence.

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LIST OF APPENDICES

APPENDIX 1A

The Deficient Cognitive Functions.

Reprinted from: Feuerstein (1980, pp76-103)
Instrumental Enrichment
University Park Press.Baltimore.

BLURRED AND SWEEPING PERCEPTION

Blurred and sweeping perception is attributable neither to the peripheral limitations of the perceptual processes nor to the way certain stimuli are sensed, but rather to the manner in which things are perceived. The perception of stimuli is marked by a blurredness of the various dimensions that characterize or define them. What characterizes the blurredness is a poverty of details or their lack of clarity, a poor quality of sharpness, an imprecise definition of borders, and an incompleteness of the data necessary for proper distinction and description. The fact that an object or stimulus is perceived in a blurred way totally affects, as well as is affected by, the processes of elaboration and output. Because we are not dealing with peripheral, sensory limitations, we are in the realm of a deficiency whose effect upon the elaborational process determines both the nature of the input and the subsequent output.

How can one explain this type of perception? The nature of the child's investment in the perceptual process, as defined by the amount of time and the degree of his persistence in focusing on an object or event, will determine the accuracy and pervasiveness of the perceptual process. So, too, speed and rhythm may be important factors in the clarity of the perception. The perceptual process may be a very rapid one in which a great deal of information is gathered during a short exposure, or it may be a slower process requiring much more investment for the same amount of information, or even less. Slow perceptual processes, combined with limited focusing, may result in reduced or inappropriate input, reflected in blurred perception. Finally, the nature of the perceived stimulus, according to such parameters as simplicity/complexity and familiarity/novelty, has important bearing on the types of perceptual investment and the amount of focusing. Thus, the adaptation of the individual will be a function of his capacity to discriminate stimuli along these parameters and vary his investment accordingly. Because such an adaptation is directly linked to the elaborative process, it very often fails in the culturally deprived, retarded performing child, whose perception may well be described as sweeping over the characteristics of the stimuli in a highly indiscriminate way.

However, sweeping perception and blurredness do not characterize all of the perceptual behavior of the culturally deprived child; there are certain instances in which his perception is sharp. Even when devoid of the verbal tools necessary to describe and formulate the perception, his perceptual processes can be complete and highly discriminating. However, these instances are usually linked to supercharged needs. When the perceptual processes are elicited by very specific and highly intensive needs that require corresponding variations in the amount and nature of investment, one is confronted by a "perfect" perception produced by the retarded performing child. Such perceptual activity, however, is rather limited in terms of the nature of the stimuli and the types of eliciting needs. It may occur rarely and for a limited universe of objects and events, corresponding to the limited need system of the culturally deprived individual.

In these children perceptual inadequacy arises because purpose, focusing, and investment are not the result of an intrinsic need system of the organism. An intrinsic need for appropriate perceptual functioning would elicit these behaviors at any time, so that appropriate functioning would not be strictly contingent upon a chance event in the life of the organism, but would rather characterize a generalized and pervasive mode of functioning.

Ample opportunity to exercise and continue perception beyond the satisfaction of primary needs is offered through the impetus of mediated learning experience. Whenever MLE has not been provided, however, perception is limited to basic needs, and its adaptive role in encounters with situations unfamiliar or not directly relevant to these needs is considerably restricted. Yet the fact that the organism is able to adapt to specific situations under certain conditions is testimony to the underlying intactness of the system. Thus, deficiencies in this function are due to a lack of appropriate habits, attitudes, and specific techniques which are acquired and established during early periods of the interaction of the organism with stimuli.

IMPULSIVITY

The retarded performer often demonstrates impulsive, unplanned, and unsystematic exploratory behavior. When presented with a number of cues that must be scanned, the individual's approach is so disorganized that he is unable to select those cues whose specific attributes make them relevant for a proper solution. For example, in the task of placing letters on a formboard, culturally deprived children often attempt trial-and-error placement, without a coordinated visual or tactile exploration of the two objects to be matched. When asked to estimate the size of an object using only tactile cues, the culturally deprived child invariably "palms" instead of keeping one *finger in place as a point of reference for identifying the object. Consequently, his recognition and estimation of objects are highly inaccurate* because of his inability to use proper investigational strategies as a result of fragmented and unsystematic exploratory behavior.

We should emphasize that impulsive, exploratory behavior is not the result of an incapacity to attend, although these two phenomena frequently appear together. Instead, it is the product of inadequate training in exploratory skills. This is reflected in a poor definition of the problem to be solved, a lack of goal orientation, and unsystematic exploration. Ultimately, the definition of a problem *is itself a function of appropriate exploratory behavioral skills.*

We must distinguish between three types of impulsivity. The first type may be determined by the basic biological rhythm characteristic of the biophysical constitution of the individual. On this dimension, there are certain basic individual differences that seem to appear only when one measures rapidity on very elementary tests, such as tapping.

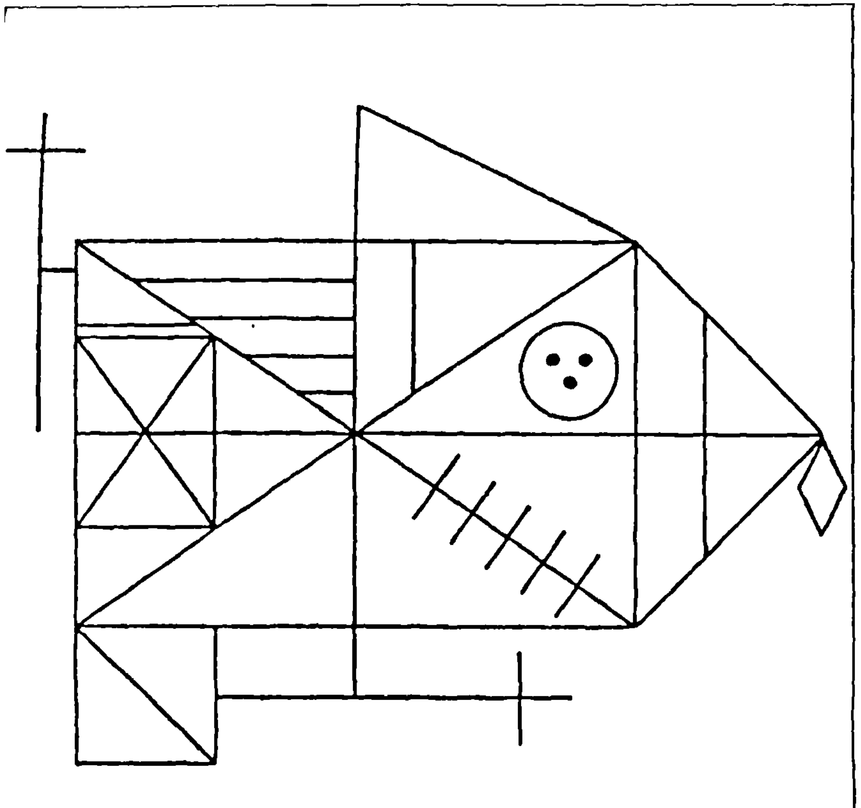
A second type of impulsivity involves control over motor behavior as a function of a process of inhibitions. Such inhibitory processes have their origin in the need to keep the response, especially that which involves a motoric act, oriented toward a more complex goal that requires both a more enriched input and a more complex elaboration. In tasks requiring both rapidity and precision, there is an inherent conflict between the corresponding processes of acceleration and inhibition. Thus, the rapidity-precision complex illustrates how the two antagonistic trends, activation and inhibition, are coordinated and converge into the obtained response. The need to balance these two antagonistic trends is very often deficient in the culturally deprived child, and the child's behavior alternates between acceleration and inhibition in an uncoordinated way.

A third type of impulsivity represents, in a more or less pure form, a cognitive dimension of the behavior of the individual. In this type of impulsivity, lack of control is not necessarily caused by the accelerated rhythm of the individual or by his lack of control over his motor behavior. It is attributable, rather, to a lack of awareness on the part of the child that certain dimensions, other than those that he has already considered, will have to be used to reach the final solution. Here, the major determinant of impulsivity is conceptual or epistemic with the acceleration of the response directly linked to the limited awareness of the need for additional data to produce the proper answer.

An illustration may be taken from an LPAD session with a Russian boy. Described as suffering from organic damage, he was referred to the clinic because of his apathy, stuttering, and slowness, both motoric and verbal. On tasks in the Raven Progressive Matrices in which the child has to select the correct answer from six choices, he usually was slow in responding and never answered before being asked to do so. This enabled us to exclude the constitutional type of impulsivity as the source of his many errors. However, when presented with the task, the boy explored for a while, then raised his eyes, looked around and ceased to focus on the task. When asked for a response, he usually gave one that was based on the use of only one source of information and was therefore incorrect. It was clear that what determined the premature cessation of his exploratory behavior was not a lack of attending, nor a lack of control, nor the instability of the perceptual process, often observed in impulsive children. Rather, his response reflected his lack of awareness that in order to solve the problem properly there were dimensions to be considered in addition to those that he had already taken into account.

In contrast to the cognitive impulsivity, the phenomenon of biorhythmical impulsivity is not necessarily more prevalent in culturally deprived children than in those who function normally. When groups of culturally deprived, low functioning Moroccan children were compared with a sample of children from Geneva on a simple motor test, such as tapping, no differences were found between the two groups. In certain instances, our clinical observations demonstrated that the deprived child behaved in a rather slow way, with greater latency periods, which reflected, perhaps, conditions of reduced energy due to undernourishment, caution, suspicion, and the like. However, differences in disfavor of the culturally deprived group were found whenever the task was based on the rapidity-precision complex which required coordination between acceleration and control. In these instances, we witnessed either blockage, affecting the rhythm in which the response was elicited, or an indulgence in an imprecise, inaccurate type of activity.

The phenomenon of conceptual or epistemic impulsivity, however, is observable in the culturally deprived child in tasks in which a rich input is required, with a variety of data to be derived from different sources, in order to solve the problem at hand. What typifies the conceptual or epistemic impulsivity is a probabilistic-accidentalist approach to the cue offered. This produces a limitation in which an arbitrary selection of data is used for the solution of a task. Of course, a combination of the three types of impulsivity may result in an aggravation of the failing behavior, depending on the requirements of the solution, its complexity, and the degree of familiarity that the individual has with the particular tasks. A good example of conceptual impulsivity at the input phase is the phenomenon of the "hand-to-mouth" response, in which the child responds to the first and most salient stimulus before he has had an opportunity to gather all the data available to him. In a test involving the reproduction of a complex figure (Rey, 1959; see Figure 2), the behavior of the impulsive child is typified by his responding in a probabilistic way to each stimulus as it appears in his visual field. This does not allow him to integrate all of the information necessary in order to produce the correct answer. Many incomplete or failing answers to the questions of teacher or examiner are the result of incompletely perceived instructions. Often an examiner is [illegible] "I know! I know!" reaction of the



ure 2. Rey's Complex Figure Test. (From: Rey, A. 1959. *Teste de copie d'une figure comxe.* (Manual). Reprinted with permission from the Centre de Psychologie Applique, Paris.)

aminee before the intent of the instructions has been properly transmitted the child.

Impulsivity may also be manifest at the output phase. One common ienomenon is the absurd, and often totally unexpected, erroneous answers fered by children in the areas of basic arithmetic computational operaons. The child answers in a totally unexpected way, which is frustrating to e questioner and to the respondent, because it is clear to both of them that e respondent really possesses the correct answer in his repertoire. Usually, is is related to the fragility of the operational system which results in its unedictability. However, the teacher often interprets this behavior as a lack knowledge and takes the failure as the true measure of the child's level, ther than considering those instances in which he does show mastery. 'hat really occurs is often the outcome of impulsivity at the output level, atibutable to the fact that the child, as well as the examiner, expects an autoatic mechanical response. Consequently, the operational process is dis-

placed by an impulsive answer. In many cases, impulsivity on the output level is followed by the spontaneous correction on the part of the examinee because of his own feeling of the inadequacy of his response. However, the pressure and anxiety generated in the child by his initial inadequate answer may result in a second answer that is no better than the first. Thus, the appropriateness of the data gathered at the input phase and the adequate elaborational processes involved in the solution of a problem become inadaptive and inappropriate only because of the child's impulsive behavior in responding.

We are often confronted with a child providing failing responses in one specific modality of output, such as oral communication, whereas his responses to the same tasks in another modality, such as gestural or written communication, are correct. The observed difference regarding failure or success on certain tasks among children is often a direct function of the preferential modality characteristic of the individual. Thus, many children will be able to provide verbally correct answers but will fail when the response involves visual or motor behavior. If this dimension is not taken into consideration, one may easily tend to confuse the inappropriateness of the output with an elaborational incapacity.

As described above, impulsive behavior may be observed in the three phases of the mental act: input, elaboration, and output. The *isolation of impulsivity* as one of the determinants of the cognitive performance of the individual is of great importance because its study may assist us in defining the nature of failure and in better understanding the cognitive structure of the individual, an understanding that can lead to more effective intervention strategies. In this respect, Instrumental Enrichment focuses its attack on the phenomenon of impulsivity within the three phases of the mental act by including in its tasks an *explicit* and *implicit* need to gather all existing information, by necessitating the inclusion of all the data provided in order to solve the problem at hand, and by introducing reflective thinking in an attempt to change the conceptual tempo of the child by imposing a temporal distance between the input and the output. Planning ahead and feedback also serve to restrain impulsivity. The tasks included in the instruments demand enumeration, comparison, and summation of objects and events, and also aid in combating rhythmical, motoric, and conceptual impulsivity.

LACK OF VERBAL SKILLS

It is clear that a lack of appropriate verbal labels will affect the input phase. This deficiency may result in the limitation of the operational use of perceived elements to specific conditions rather than the generalization of those dimensions to other tasks when possible. The fact that a child cannot formulate the outcome of a comparison by using relational terms may result in his inability to apply the relationship deduced from comparing two objects or events, even if intuitively he is able to perceive their commonality or difference. Haywood and Switzky (1974) provide evidence that deficiencies in verbal skills among culturally deprived children are characterized not by an inability to form verbal abstractions but by a reduction in the intake of information. They found that enriching the supply of information produced normal performance levels on verbal abstracting tasks.

A lack of verbal skills may also severely affect a child's ability to elaborate certain cognitive operations. The absence of a specific verbal code to designate certain attributes of an object will not only affect efficiency at the input phase; on the elaborational level, lack of operational terms, such as "opposite," "relation," and "identity," may keep the child bound to specific tasks that he can handle on a concrete level and may impair his ability to generalize the same operation to tasks differing in content and complexity. Without entering into a discussion of the role played by language in the generation of thought processes, which is an area of dispute (see, for example, Bruner, Olver, and Greenfield, 1966; Piaget, 1968; Vygotsky, 1962), no one denies the facilitative role that verbal labeling plays in processes of generalization. In this particular case, the verbal labels represent important tools for designating the mental operation itself. In teaching an analogy task to the child, the most important aspect is to make him deduce the relationship that will then permit him to use it for the construction of a similar pair. However, in teaching this relationship, the capacity of the child to generalize his behavior will depend on his ability to understand the concept and the operational meaning of the term "relationship" and some of its specific contents. Inappropriate or imprecise verbal tools may still allow the child to operate, but the existence of the appropriate labels will turn this operation into a more universal key in solving similar problems.

In discussing the lack of verbal skills, a sharp distinction must be made between the culturally deprived and the culturally different. Both may lack the appropriate concepts or labels for functioning in a situation, but for very different reasons. For the culturally different, this deficiency may reflect a cultural difference in verbal and cognitive styles. In this case, the basic concept may exist but there may be a difficulty in selecting the correct corresponding linguistic term. The culturally deprived child, on the other hand, may have the label but not the corresponding concept. Alternatively, he may lack the verbal label because he does not discriminate between two otherwise distinctly perceived objects.

Mediated learning experience is not solely and necessarily dependent on the verbal capacity of the mediators, but also depends on their readiness and ability to transmit the appropriate verbal tools to the child. The lack of a proper term to designate an object, sequence, relationship, or concept will not, of necessity, limit mediational processes between the child and the adult. Whenever such verbal tools are missing, they may be substituted for

tion. However, if the absence of transmission is combined with a lack of verbal tools, the outcome will be a severe lack of the prerequisites of operational thinking. Of course, the existence of verbal codes permits the use of more complex relationships and facilitates both the understanding and communication of more abstract components. Confronted with more abstract and formal logical operations, the lack of verbal tools makes the mastery of such tasks very difficult, and, in many cases, uneconomical to the point of being prohibitive.

In short, many operational activities and their prerequisites can be conceived of as being independent of a verbal, semantic system of labels. Labels are necessary, however, when more complex and abstract relationships are required and ensure their more efficient use and application.

LACK OF, OR IMPAIRED, SPATIAL AND TEMPORAL ORIENTATION

Temporal and spatial dimensions are among the cognitive functions whose development is strongly dependent upon mediated learning experiences because they are based mainly upon relational thinking. They represent a level of functioning that transcends the "here" and "now," and the isolated unique existence of an object or of an event. They describe, rather, the way objects or events relate to others in terms of order and sequence, distance and proximity, and the like. Direct exposure to stimuli without an adequate orientation toward time and space reduces cognitive functioning to the level of simple identification and recognition of objects without permitting the establishment of relationships between them.

Temporal and spatial orientation more than certain other cognitive dimensions depend on MLE to become established into the cognitive repertoire of the individual. What would we know about a past that is not directly experienced by us if it had not been transmitted to us? The mediational processes reflected in the transmission of the past create representational thinking as a modality to relate to and act upon the "represented" as one would to the "experienced." Continuous exposure to the past also has important bearing upon the capacity to plan ahead and to relate to the future, operate on it, and produce transformations in it by hypothetical "iffy" thinking. This may result in a habitual disposition to register time and to order space, to organize and coordinate them according to specific needs, and to use them as the necessary condition for the precise definitions of objects and events.

Clinical observations of culturally deprived individuals have demonstrated again and again an impairment in their level of functioning in tasks requiring spatial orientation. This deficiency is clearly observable in a positional learning test in which children have to learn the position of five particular squares on a 5×5 grid. The gradualness of the learning curve or their failure to learn at all is easily traced to an incapacity to orient themselves by *so on. The fact that these children have to rely on the perceptual pattern of the cues, which itself is difficult to establish because of their episodic grasp of reality, makes learning very slow and unstable and, in some cases, even* impossible (Feuerstein, Krasilowsky, and Rand, 1978).

The culturally deprived individual frequently is dependent on his own body movements for spatial orientation. For example, when giving directions, culturally deprived individuals will often use gestures that are limited to their own movements rather than using terms like "right" or "left." They may even propose accompanying an individual who has asked for directions to the site in question because it is easier to do so than to conceptualize spatial relations. Our experience indicates that merely inhibiting the gestures and movements of the culturally deprived child often results in the emergence of more conceptualized, interiorized handling of spatial orientation.

Impairments in representing, projecting, conceptualizing, structuring, and organizing space have implications both for psychological testing and for actual learning. Culture-free and culture-fair tests, which are designed largely for the culturally deprived populations, normally have many items that require spatial discrimination. The impairments of culturally deprived youth in this area, however, often preclude their succeeding in the very nonverbal performance tests specially designed not to penalize them for their generalized or specific deficiency.

Temporal orientation seems to be deficient more often than other factors in culturally deprived populations. Because time is an abstract element and requires representational relational thinking, it is a concept far more difficult to master than certain types of spatial relationships, especially those of functional space. Of the two, the concept of time, even more than that of space, is especially dependent on mediated learning experiences for its acquisition. Thus differences in the registering and orientation of time may be found between the culturally deprived and the culturally different. The culturally deprived child's attitude is characterized by the lack of a need for ordering, summating, comparing, and sequencing, all of which must be produced initially by a volitional act on the part of the individual. In contrast, the attitude toward time that may characterize certain culturally different individuals is reflected in a more casual and inefficient attitude and use of time. A readiness to "kill" time or to "waste" time does not necessarily imply a lack of temporal orientation as such an attitude may be accompanied by a great deal of awareness, even to the point of registering and summing up the time wasted.

A lack of temporal orientation is not necessarily linked to the lack of, or inaccuracy in the use of, proper verbal tools. In certain cases, there may be a generalized episodic grasp of reality and a lack of summative behavior that make the child neglect the grouping of objects and events because he has not yet established quantifiable or ordering relationships among them. However, the most prevalent factor in this deficient cognitive function is the lack of orientation toward time in attributing meaning to one's experience of objects and events and the relationships among them. Thus, "before" and "after," as well as the "now" and "then," are very vaguely defined, if mentioned at all, as attributes.

This lack of temporal orientation and the inaccurate use of temporal concepts affect the individual's capacity to use the data registered by him in an accurate and well defined way. Both spatial and temporal concepts are needed in order to define our perceptions. The uniqueness of a percept, in contradistinction to its general or universal character, is provided by inserting the object or the event into the matrix of time and space.

When relationships between objects and events are the content of our mental operation, a clear understanding of the concepts of time and space is essential. Causal relationships and concepts of transformation cannot be conceived of without recourse to spatial and temporal dimensions. Of the two, the temporal is less accessible and, consequently, much more deficient in the culturally deprived child. Whereas the spatial orientation may be dealt with by the culturally deprived in a more concrete operational manner, the temporal dimension is inaccessible to the concrete and therefore produces greater difficulties. The difficulty in grasping temporal dimensions is related to the fact that they are handled almost exclusively by an internal feedback and representational registration. Therefore, they depend not only on the generalized attitude of summative grouping behavior but also on the need and the capacity of the retarded performer to represent to himself, and to act on, data derived and summed representationally.

An orientation toward time and space, produced by MLE, crystallizes and becomes an automatic response, which is then regarded as an attribute of human perception rather than as a product of special effort and a volitional act. It is this automatic character of our time-space orientation which is then conceived of as an *a priori* condition of our thinking. However, temporal and spatial functions are heavily impaired in the retarded performer and the result is an imprecise grasp and organization of objects and events and relationships between them.

LACK OF, OR IMPAIRED, CONSERVATION OF CONSTANCIES

Perceptual stability is, to a large extent, dependent on the capacity of the individual to conserve the constancy of objects across variations in some of their attributes and dimensions. Such constancy is produced either by perceiving the variation in given attributes as irrelevant to the identity of the object or by conceiving of the variation as being produced by a transformation of the given attributes of the particular object that does not affect the identity of the object because it can be easily reversed to the original state through another transformation.

Reversibility is the mental process underlying the conservation of con-ancies under conditions of transformation. Lack of, or impaired, conser-ation of constancy often is associated with an episodic grasp of reality in hich objects and events are not related to each other. Because an episodic asp does not result in the establishment of a relationship between the per-ived objects and experienced events, it does not make possible the under-inding of the identity between them by eliminating, as irrelevant, transfor-itions of the attributes. For example, a square placed on its angle is often nsidered a triangle by a child because the variation in the square's spatial ientation has made the child use the irrelevant attribute of its standing on angle in his identification of the object. The shift in orientation has made : child neglect the more important dimension of a square, its four angles her than three. The lack of conservation of constancy is manifested in a iited disposition to conceive categories of objects above and beyond dif-ences between them because of the lack of readiness on the part of the arded performer to accept a common factor as constant and to abstract s common factor from other dimensions on which the objects may differ. ius, the phenomenon of the conservation of constancy can explain the dif-ulties experienced by the child on a conceptual level in producing proper perordinate concepts.

ıCK OF, OR IMPAIRED NEED FOR, PRECISION AND ACCURACY

ıe function of a lack of, or impaired need for, precision and accuracy was :ntioned in the previous discussion of impulsivity. However, the level of :ognized need for precision is also affected by cultural differences and/or lividual differences in the focus of interest.

The distinction between the lack of precision of the culturally different d of the culturally deprived can be seen in the ease with which the need for ecision emerges in the culturally different individual once he is confronted th tasks that elicit such a need. In contrast, the culturally deprived child inces a resistance to the establishment of such a need despite the re-iirements of a specific task. The response patterns established in the cultur-ly different child as a result of MLE, with respect to culture-specific con-nts, will be readily applied to new contents with which the individual is ınfronted. This is because of the modifiability produced in an individual as result of MLE. However, where the lack of precision is the result of a lack f MLE, as in the culturally deprived individual, the child will be more resis-ınt to changes imposed by the nature of a task requiring precision.

Two categories of imprecision may be distinguished: missing data and istorted data. In the first category, the individual does not take the care to ather all the data he is offered and hence cannot use the information when ıe has to produce an answer or is required to report on a perceived object or vent. Imprecision is thus manifest by partial gathering or partial transmis-ion of data on the input and output levels, respectively. In the second cate-gory, imprecision may be the result of a distortion of certain dimensions. In this case, data are not missing but there may be approximations rather than precise attributions or the use of qualitative rather than quantitative dimen-sions.

The dynamics of the orientation toward precision is based on a general-ized need, the application and use of which are affected by more specific needs. The general need is established by a variety of strategies very early in the interactional processes between the child and his human environment. This interaction, reflected in a dialogue in which each partner is provided with feedback on the efficiency of his communication, is certainly one of the most potent factors in establishing the general need for precision. The more a dialogue bears upon topics distant from the immediate perceptual field, the greater is the reliance upon precision in the communication of the specific subject of the dialogue. Feedback on communication gaps produced by im-precision will produce in the individual a need to gather all the data and ex-press them in such a way that his partner is able to understand and react ac-cordingly.

This interaction starts at a very early age, with the gathering of data as a product of instruction or as an answer to an explicit request. It is then followed by corrective responses, and, throughout the process of habit for-mation, precision becomes less dependent on explicit instruction and is man-ifested as an internalized intrinsic need to be exhaustive and precise in gath-ering all the necessary data. This need may also result in incidental learning, in which certain sets of data not of immediate relevance are registered, stored, and readily mobilized, despite the absence of specific instructions to do so.

Precision may be impaired or lacking not only because it is not experi-enced as a need, as such, but also as a secondary result of deficiencies in other cognitive functions. There are some types of imprecision that may arise as a function of deficiencies of the elaborational processes. For exam-ple, certain dimensions and relationships become salient and relevant only when they gain a specific meaning through comparison. Therefore, if one does not compare, then the accuracy and the precision of the description of the dimensions included in the perception of the object will be far less than if, in perceiving, one sets out with the intention to compare. Lack of preci-sion at the output level may differ from that on the input level. In addition to cognitive factors, differences may also be attributable to the nature of the re-lationship between the individual and his partner in the communicational in-teractions, which may be reflected in egocentric modalities of output.

LACK OF, OR IMPAIRED USE OF, TWO OR MORE SOURCES OF INFORMATION

The function of lack of, or impaired use of, two or more sources of informa-tion is included as a deficiency at the input level, despite the fact that it is actually the outcome of an elaborative process. The use of two sources of information is a prerequisite of thinking because it is the basis of all relational thought processes. Two elements must be used as sources of data in comparative behavior and whenever a problem is confronted. In fact, no prob-em can be experienced as such unless an incompatibility of data stemming rom two or more sources is identified and confronted.

The capacity to conceive of the congruity and incongruity among multi-le sources of information is the *a priori* condition for the need to reinstate, y means of a specific operation, the equilibrium (i.e., to solve the problem). rom this point of view, the use of two sources of information is, in itself, an laborational process. If the individual constantly tends to relate to each ource of information separately, either successively or alternately, but does ot coordinate the two, the elaborative process will be impaired because the elationship between the two sources will not be available for further experi-nces.

If the individual is not oriented to gathering all the data from various ources, but rather satisfies himself with only one source, then the input is in-dequate and his functioning will be limited to the simple identification or ecognition of perceived elements. The lack of disposition to use two sources f information at the input level is a phenomenon observed in many situa-ons and accounts for much of the unsuccessful performance of children on sychometric tests and in particular academic and everyday life situations. or example, in tasks relying on visual perception, this phenomenon is early evident when the child is offered a variety of possibilities and takes to account only one source from a series of alternatives. That he has used looked at only one source becomes clear when analyzing the nature of his ror. Often the response is appropriate if one takes into account that it cor-sponds to the single source of information that was considered.

Results obtained with Moroccan and Israeli children on the Raven Pro-essive Matrices (Raven, 1947, 1960) have been analyzed in terms of the ildren's errors. This analysis produced evidence that the majority of errors ere attributable to the use of only one source of information. In tasks re-iiring the completion of missing parts by selecting from six alternatives (see gure 3) the French-speaking Moroccan children almost invariably chose e part that was identical to the given lower-left section of the square, in-ead of selecting the appropriate complementary part. Unlike their French-ading peers, Hebrew-reading culturally deprived examinees chose the part rresponding to the given upper-right section. They did so because, accus-med to starting the perceptual exploration from right to left, as in reading ebrew, they encountered the right part of the page first. In both cases, the e of only one source of information prevented the children from establish-g the necessary relationship between the parts.

The limited need of the retarded performing child to use a variety of urces of information makes for difficulty in his grasping the point of view

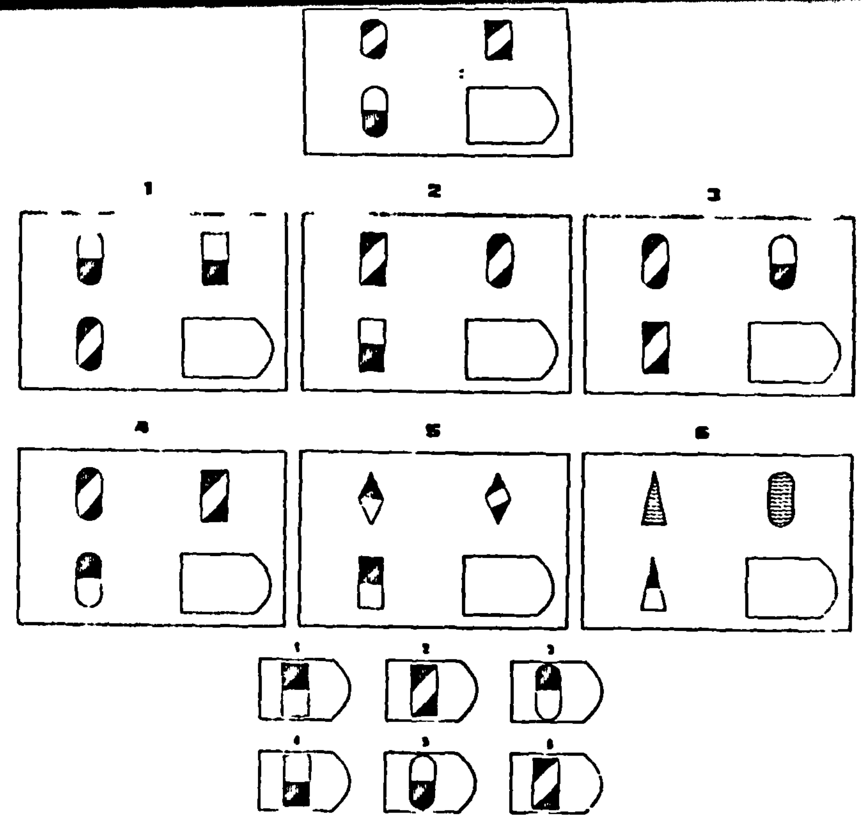


Figure 3. LPAD Variations I.

of someone else and coordinating it with his own. The use of two sources of information is a prerequisite to what Piaget calls "decentration." Piaget maintains that egocentric behavior occurs because the individual is unable to see the "other" and represent himself in the situation of the perceived "other." Before disengaging oneself, one must be able to seek two or more sources of information. This lack of orientation toward, or search for, two sources of information produces limited input and heavily determines deficient elaborational processes.

INADEQUACY IN EXPERIENCING THE EXISTENCE OF, AND IN SUBSEQUENTLY DEFINING, AN ACTUAL PROBLEM

The function of inadequately recognizing and defining a problem involves the inability of the individual to grasp the disequilibrium existing in a given situation. If the disequilibrium does not produce an awareness in the individ-

l of the change that occurs in his internal state, the existence of the prob-n will not be experienced. The origins of reflective thinking, as noted by wey (1933), lie in perplexity, confusion, or doubt. Reflection does not se spontaneously in an individual but must be evoked by the disequilib-*rn inherent in a situation in which incompatibility exists between two or re sources of information.*

Why is the culturally deprived individual not sensitive to, or disturbed the existence of a problem situation readily experienced by others? We d that a number of poorly developed cognitive functions are responsible this unawareness. First, the experience of a problem requires the gather-of data for the subsequent establishment of relationships between the ous cues. This is followed by an appreciation of incompatibilities, dis-ancies, incongruities, and missing cues via the establishment of relation-s between various sources of information that may be present in the per-ual field or in stored information. By way of illustration, the reaction of ses to the burning bush (Exodus 3.2) may be cited. Stored information le him expect that the bush would be *consumed* by the flame while his ceptual experience conveyed that the anticipated result did not occur. The ompatibility between the *stored* and *current information* produced a blem, which was experienced *as a state of disequilibrium.*

> ...and Moses said "I will turn aside now, and see this great sight, why the bush is not burnt" (Exodus 3.3).

This state of disequilibrium acted as the energetic determinant of a reac-1 *whose aim was to restore the equilibrium between the perceived facts those anticipated on the basis of previous experience. In the* Biblical situ-n, the solution was offered by the miraculous nature of the incompatible unexpected condition. In other cases, additional information, such as condition of the wood or the illusory nature of the phenomenon per-ed as fire, might have solved *the problem.*

Unless the necessary initial step of data gathering is undertaken with a licum of attention and skill, the understanding of a problem will be non-lent *or partial*, at best. Dewey (1933), in his classic book *How We Think*, *mented on the importance of the initial steps* of data gathering and the blishing of relationships for reflective thinking. The way in which the ject matter is supplied and assimilated is, therefore, of fundamental ortance. If the subject matter is provided in too scanty or diffuse a fash-,or if it comes in disordered array or in isolated scraps, the effect is detri-ital to cognitive processes. However, if the data gathered are adequate, ther through personal observation or through transmission of informa-by others, half of the battle is won, because this is the prerequisite for orating relationships and experiencing them as a problem to be solved. The lack of a variety of culturally and experientially developed needs contributes to a nonawareness of problems. Consider culturally de-prived youths' lack of need for logical evidence. Cognitive systems, which do not demand that events necessarily follow from a given set of circumstances, will not appreciate discrepancies existing in the field. On the other hand, a complete lack of interest in the field, which is a frequent reaction of these youths to academic studies, will not lead to an arousal of curiosity that would signal an encounter with a problem situation.

On a more practical level, in the classroom when the retarded performer is presented with a problem situation and is instructed in its solution, both the phrasing of the problem and the instructions may not be understood purely on a verbal level. As has been stated, not attending to appropriate cues is the basis for the lack of awareness of the existence of problems, but the fact that a problem is not recognized, as such, acts circularly to perpetuate the chain of not organizing the field toward the solution of problems.

INABILITY TO SELECT RELEVANT AS OPPOSED TO IRRELEVANT CUES IN DEFINING A PROBLEM

The relevancy and irrelevancy of cues are a direct *function of the specific* goals established by cognitive process on the elaborational level. Relevance is always related to a specific goal. Therefore, in describing an *individual as unable to discriminate between the relevance and irrelevance of certain cues*, it is necessary to first define the specific goals that will determine his aware*ness, his amount of focusing, and the degree of relevance of each cue. In* other words, relevance and irrelevance of cues are a direct function of the purposefulness and degree of goal orientation of the mental activity of the individual. The more purposeful and goal oriented are one's cognitive processes, the greater is the differentiation of the perceptual field with regard to the relevance of specific cues to meet these particular goals.

It is clear that we are dealing here with the need system of the organism, which *renders* him receptive to recognition of a problem and creates a search in the field for relevant data that may help reinstate the equilibrium by solving the problem. In this search, cues will be assessed with respect to their relevance or irrelevance according to their capacity to reduce the state of incompatibility of the processed data. For example, when a child is presented with six choices of equal size that differ in color and shape, and is asked to complete a missing part, size is irrelevant because it does not discriminate between the various alternatives. Thus, by defining the goal the common features of the alternative choices are judged as irrelevant to the problem at hand.

In certain other cases, the discrimination between the relevant and the irrelevant is produced by an analytic process that permits the elimination of certain cues and the assignment of preference to others. Hypothesis testing, which aims at the isolation of the determining factors of a given situation, is the case of discrimination between relevant and irrelevant cues. In distin-

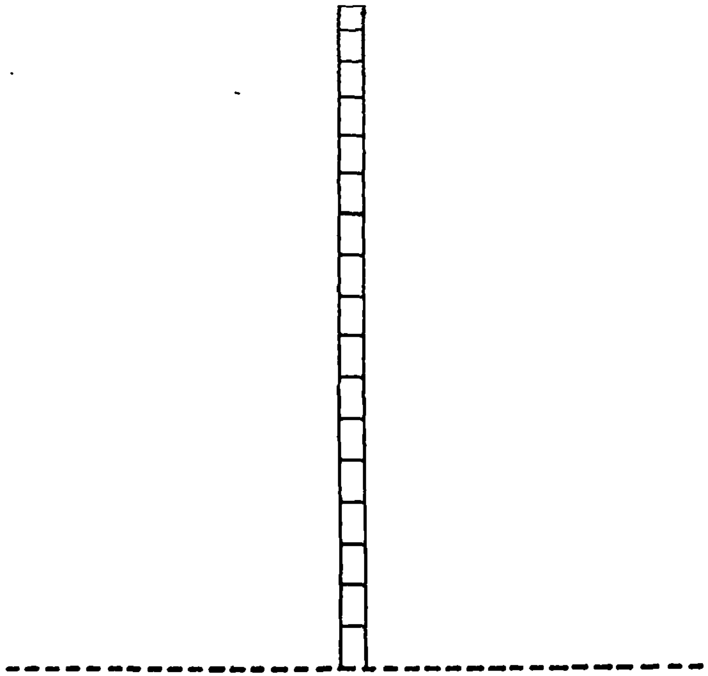


Figure 4. Horizontal-vertical illusion.

guishing between factors that determine the horizontal-vertical illusion (Figure 4), in which there is an illusory difference of size between the two lines, the search for determinants may result in the ascription of causality to irrelevant factors such as differences in the color of the lines, until their irrelevance is proved in an analytic experimental way. Lack of discrimination between the relevant and irrelevant units of information is also linked to an inappropriate or inexplicit definition of the problem, which produces a lack of purposefulness in the perceptual processes of the individual. This leaves the cues unorganized with little or no difference in the degree of relevance ascribable to each of them.

LACK OF, OR IMPAIRED, SPONTANEOUS COMPARATIVE BEHAVIOR

Spontaneous comparative behavior may be viewed as the primary condition for the establishment of relationships because it entails the organization and integration of discrete units of information into coordinated thought. As such, it is considered by the author to be one of the most fundamental building blocks of higher cognitive processes. A deficiency of spontaneous comparative behavior limits cognition to the most elementary processes by excluding the involvement of higher mental processes. By means of the products of spontaneous comparative behavior, an individual is able to transcend his immediate perceptual experience and is able to draw logical inferences which lead to abstract, propositional, and hypothetical thinking. Thus, it is on the basis of comparative behavior that the child's construction of reality relies, as aspects of the outer world are organized into meaningful systems in terms of the relationships that he imposes on them.

We do not contend that the culturally deprived child is unable to compare or even that he does not do so in all situations. On the contrary, the fact that the child is usually successful in comparing when specifically requested to do so is sufficient evidence of his ability to compare. The deficiency in this case lies in the failure of the child to compare spontaneously. We have witnessed many children who perform poorly on psychometric and academic tasks because the necessity for comparison, in order to solve a problem, was not explicitly stressed. When the necessity to compare is indicated to the child by verbal or even nonverbal means, he is often able to proceed successfully with the task. Because the need to compare is usually taken for granted, very little experimental work describing and measuring spontaneous comparative behavior has been undertaken.

In short, comparative behavior is a prerequisite of relational thinking which leads to conceptual processes. It determines, as well as is determined by, the nature of the input and output processes. Factors such as systematic organization, need for precision, summation of attributes, and ordering of relationships may be outcomes of adequate comparative behavior.

NARROWNESS OF THE MENTAL FIELD

The culturally deprived child often demonstrates a narrow mental field which limits drastically the number of units of information that can be processed and manipulated simultaneously. This limitation results in an incapacity to use varied bits of information for the internal combination and coordination necessary for the production of conceptualized operational thinking. In many cases, this is manifest by an alternation and succession rather than a coordinated integration, so that objects and events are not considered in relation to each other but as independent entities.

On the level of memory, there is a loss of fragments of previously acquired information once the individual changes the focus of his attention to other information derived from the same source. This is illustrated figuratively by the "short blanket" phenomenon in which one uncovers one's legs by covering one's head and vice versa. On the Plateaux test, for example, in which the child has to learn the position of one fixed knob out of nine on each of four plates, or even in a test of memory for fifteen words, many of these children are unable to retain those elements that they are able to recall at first, once they succeed in remembering others. This phenomenon can be ascribed to a variety of factors, but in the retarded performer it seems to be linked to the passive attitude of the child toward his own self as the medium hrough which cognitive processes operate but over which he exercises no 'olitional control. Remembering is conceived of as a "happening" that in- olves limited control of the individual rather than as an active process of construction of the experienced reality. It occurs *to* him and not *by* him. hus, children asked in clinical assessment about the control over their mem- 'y describe it as either "there" or not.

The retarded performer does not manifest a belief in his own capacity recall a memory, which is not evoked immediately and spontaneously, will. This may be regarded as a particular case of the more generalized enomenon of extrinsic locus of control, characteristic of these children, iich makes them dependent on what will happen to them rather than on iat they can make happen to themselves and to others. They do not con- er themselves generators of information beyond what emerges within m as a consequence of a specific directed effort. Therefore, if a child nembers certain dimensions quickly and spontaneously by virtue of their ater immediacy or saliency or through increased vigilance, he will be in- ied to renounce other information of greater relevance and importance ause it is not as easily accessible to him.

An acceptance of oneself as a vehicle through which information passes passive and random manner rather than as a source and generator of in- mation, combined with an inability to combine and coordinate units of ormation, produces a narrow and restricted mental field.

CK OF, OR IMPAIRED NEED FOR, SUMMATIVE BEHAVIOR

ack of summative behavior is a characteristic of the culturally deprived in- idual that leaves the stimuli registered by him isolated and unique. A com- n tendency, observable in even young children, is that a sort of running nputational system is used, which manifests itself in adding objects and nts and summing their appearance and frequencies without a very specific l-oriented need to do so. The so-called child arithmomania, which mani- s itself by the child's propensity to count sticks, telephone poles, cracks he pavement, fence pickets, and the like, is but one manifestation of this d to have things summed up in inclusive terms. This purposeless and tuitous type of behavior, often executed aloud as a soliloquy, with time l exercise becomes an *internalized* activity, permitting children to group, npare, subtract, and even multiply events, thus updating them as they oc- . When asked, children may well be able to offer a summative account of se events without having to add them at that particular moment. Summa- *behavior represents a basic need to produce relationships in the world,* l *it reflects* the active contribution of the organism in his interaction with external and internal processing of stimuli.

The child who manifests a deficiency in summative behavior is often unable to give a spontaneous accounts of events with which he is confronted daily and with which he is thoroughly familiar. When asked, "How many children are there in your family?", "How many rooms are in your house?", or "How many children are in your classroom?", he will be taken by surprise at not having done what seems to be most natural. The child will start to enumerate names and events. His difficulties are not technical, because he is able to count when requested to do so. Instead, they reflect a lack of orientation to sum up reality as a part of a need to organize one's interaction with stimuli. Such a need is the product of mediated learning experience and is not generated directly by exposure to reality.

Summative behavior not only is confined to quantitative dimensions, but also includes a qualitative aspect. In both its quantitative and qualitative form, summative behavior represents a necessary prerequisite for logical operations. However, the need to summate objects and events should not be confused with the operation itself, which may involve any of a number of different logical operations.

DEFICIENCIES IN PROJECTING VIRTUAL RELATIONSHIPS

Deficiencies in projecting virtual relationships are concerned with those relationships that have been established and grasped but have not yet been applied in the handling of a new situation. The relationships exist "virtually" in the individual but remain to be projected into a specific constellation of *objects and events. Thus, this deficiency involves the need to restructure a* given constellation and then to shift from one type of relationship to another as required by new tasks confronting the individual.

LACK OF, OR IMPAIRED NEED FOR PURSUING, LOGICAL EVIDENCE

The definition of problems and the search for their solutions is strongly contingent upon the presence of a feeling of cognitive dissonance (Festinger, 1957) and disequilibrium (Dewey, 1933; Piaget, 1952), generated by the incompatibility or incompleteness of data in a *given situation. A feeling of* compatibility is *derived* through *the* grasp of *the relationships either between* objects present, or between a given object or event and previously stored information. However, even if the problem is experienced and incompatibilities are felt and registered, a search for solution may still be lacking if no need to change the situation in order to restore the disrupted equilibrium is felt. When we are confronted *with an attitude that induces an acceptance of* things as they are, the need for logical consistency is not deemed essential in the same way that other needs are experienced. "So what?" is often heard in response to situations that, in the regular child, would give rise to a storm of questions and search for answers.

The lack of need for logical evidence does not necessarily reflect a low level of intelligence, even though it certainly impairs cognitive functioning. Rather, it should be understood as an attitude of the individual toward the quality of interaction between himself and his external and internal environment.

In analyzing many of the responses given by children to some of the Piagetian type of tasks, it has been found that the failing behavior of the children can be explained by the fact that they are not disturbed in the least by the illogical relationship between the reality of the situations and the instructions accompanying the task or by the even more frequently occurring illogic of their own responses. Our conclusion is that a lack of need for logical evidence does not necessarily reflect a deficiency to operate logically, because the child's responses sometimes do demonstrate logical understanding. Rather, the inconsistency frequently observed in the child's responses may be ascribed to a faulty need system in which logical evidence is not prominent *and pertinent, a condition which, in fact, may be noted* even among some *normal initiated adults.*

Lack of need for logical evidence is commonly observed in the communication patterns of the culturally deprived child. Frequently an inferential question of *"Why?"* will be responded to with a sequence of "Because" *"Because why?"* "Because of because." This is but one example of the typically given inappropriate answers to simple informative questions, and simply attributing this inadequacy of the answers to emotional states is not supportable. Instead, logical evidence is not experienced as a compelling force or dimension with which the individual should be concerned.

A lack of need for logical evidence affects not only the output phase, in which the individual supports a statement and his judgments in a way that will be acceptable to his partner, by using rules commonly accepted by both, but strongly affects the input levels as well. If, in proposing a statement, one is not compelled to bring to bear evidence that will be acceptable to one's discussant, then the data supporting the proposition will accordingly be imprecise and incomplete. Lack of need for logical evidence is, therefore, a major determinant in the failure of the culturally deprived child and has important implications not only for academic activities but for behavior in a wide diversity of areas.

This particular function is often confounded with certain defense mechanisms characterizing neurotic, regressive behavioral patterns. As pointed out by Odier (1956), there are important common features between the regressive thinking of the neurotic and patterns of behavior typical of early stages in the development of cognitive functions in children. Our claim is that we are not dealing here with regressive types of behavior reflecting inadequate defense mechanisms, nor with fixation on lower stages of development, but with functions that are deficient as a result of the lack of mediated learning experience.

One of the frequently observed and well recognized phenomena in the retarded performer is a strong reliance upon concrete perceptual cues accompanied by a lack of readiness to use representational mechanisms by actively manipulating stored information. This has as its corollary the frequently cited pervasiveness of task-bound concrete behavior, with inappropriate generalization and a low level of abstraction. The distance between the mental act and the objects on which it operates is usually very narrow, with a limited use of mediating symbols, signs, and concepts. The child frequently tends to refer back to the initial object or event on which he was operating. In many cases, this concrete approach is the expression of the child's disbelief in his capacity to invoke or "hallucinate" the reality which he seeks and which is not accessible to his sensorial system; to represent to himself the object without having it in front of him; and to retrieve, by way of representation, something that is not in his immediate sensorial field. When asked to free associate, many of these children will limit themselves to the evocation of words for the objects perceived in their immediate environment and will have relatively greater difficulties in evoking things that are not present. The same is true for reports of events in which only very limited aspects are mentioned, usually those that have had a material and observable impact. When asked an inferential question based on data gathered and analyzed, the child will answer, "But, how can I say *what it will be if I haven't seen it yet?" In* requiring the child to represent to himself the outcome of a transformation, his initial response will be, "How can I know if it has not yet been done?"

This tendency is often supplemented by an educational approach that emphasizes sensorial stimuli and concrete motor behavior as the preferred, if not the sole, way to teach these children. Thus, the lack of interiorized representational behavior not only is the product of a lack of mediated learning experience, at both early and later stages of development, but is reinforced as well by prolonged and exclusive exposure to and reliance upon concrete sensorial data. The lack of interiorized representation has an important bearing on both academic and nonacademic behavior. Planning cannot be conceived of without interiorized representation as a plan in the attempt to bridge between the present and a nonexistent future. It aims at a goal which, by definition, is not yet concretized. Planning is exclusively dependent on the representation of interiorized goals. The incapacity of the individual to represent to himself the future or the outcome of a transformation may severely limit his behavior because it will reduce his judgment and, even more, confine his needs to the "here" and "now."

The well known and frequently cited incapacity of these children to delay gratification, often characterized as a personality and motivational trait, is interpreted differently in our framework. We see the unwillingness to delay gratification and the "here and now" orientation as attributable mainly to the limited capacity of the retarded performing individual to represent to himself a nonexistent future. This does not of course negate the importance of many non-intellective factors active in the life of the deprived child, such as a lack of security or a lack of prospects for a better future, which contribute to a predisposition for opting for the immediate. The choices of the culturally deprived are strongly delimited by the few existing alternatives that are usually taken from the "here and now." It is easier for the child who lacks the capacity for interiorization to represent to himself the pleasure of using all of his money on goodies than to anticipate the pleasures and benefits involved in delaying his gratification. By the same token, the capacity to delay gratification for the benefit of a more remote goal is strongly limited by the lack of capacity of the individual to represent such goals to himself or to compare the represented goals with his current status or with the expected outcome of his yielding to immediate gratification. Interiorized representational thinking is a highly complex product involving a great variety of cognitive components that combine with motivational and emotional determinants of behavior. Therefore, the readiness to plan ahead will vary in different individuals according to cognitive, emotional, and attitudinal dimensions.

The author remembers his own experiences of being shocked at the long-term planning behavior of his colleagues in the Kibbutz. Their 5-year plan seemed to him futile and totally unrealistic against the background of his previous day-to-day experience in a concentration camp where one could not conceive of a future beyond the hour. The same is true in many other situations in which planning is not economical. Failure to plan ahead thus does not always reflect an incapacity for or lack of interiorization. It can be attributable to the environment or internal motivational attitudinal conditions of the organism. However, in the case of the culturally deprived, the cognitive components, such as lack of interiorized representational behavior, should not be underestimated and may even be more prominent than the motivational affective factors.

LACK OF, OR IMPAIRED, PLANNING BEHAVIOR

Deficient planning behavior is mentioned above in the description of interiorization with respect to the construction and representation of more remote goals. However, planning not only consists of setting of goals that are located both temporally and spatially at a given distance from the "here" and "now" but also involves the dissociation of the aims set forth from the means necessary to achieve them. This dissociation requires a further differentiation of the means in terms of the steps that are necessary to achieve the final goal. The steps must be planned according to a certain degree of detail, must be ordered in terms of their temporal sequence, and must be judged for suitability in terms of investment, feasibility, economy, and other criteria that may be critical for the individual. Thus, the planning of one's vocational future may require unpleasant detours involving a maximum of investment in, and commitment to, activities that are not necessarily consonant with one's immediate needs. The readiness to plan and accept such an investment is closely related to the capacity to enumerate and sum the required activities and compare them with the anticipated outcome. Such planning behavior is usually learned and exercised on short term goals and is then applied to long range objectives as a response to the enlarged system of needs and the possibility of anticipating satisfaction and fulfillment.

The incapacity to anticipate the outcome of behavior may be caused by deficiencies inherent in the individual, such as a lack of representation, a lack of intrinsic locus of control, and so on. It may also be attributable to the objective situation which makes prediction a very difficult, if not impossible, task. In the case of the culturally deprived, these two determinants may converge and combine in reducing planning behavior to a minimum. Individuals who have been raised in conditions of poverty and constant danger may fail to plan and anticipate because their life conditions have never allowed them to actively determine their own future. Such individuals have been taught by circumstances that there is no alternative to a hand-to-mouth existence because they cannot foresee, much less determine, what the next moment will bring. This may be, and in certain cases may become, the reason for a reduced need to plan one's behavior. Because the individual is never put into a position of having to predict, he does not acquire the necessary skill and orientation toward planning behavior. This, in turn, may affect other functions at the input and output levels and thereby render attempts at future planning uneconomical.

EGOCENTRIC COMMUNICATIONAL MODALITIES

Egocentric communicational modalities refers to an impairment of communication output as a consequence of the way in which an individual regards his partner with whom he is involved in a transaction. Egocentric communication is a function of a lack of differentiation, which does not allow the individual to see his partner as different from himself. This differentiation is a necessary condition for making communication explicit by producing all the evidence necessary for the listener's comprehension of the information conveyed to him. In many cases, the child limits his communication in terms of detail, precision, and argumentation because of the attitude "How can he think differently than I do?" or "How is it possible that he doesn't know what I know?" This type of undifferentiated approach to another is even more accentuated when the interaction is between a child and a teacher or examiner. The child is not willing to accept the idea of being examined and limits his responses to the necessary minimum because it is clear to him that his responses are well known to his partner and, therefore, futile to communicate.

The egocentric communication modality is apparent when there is a necessity to provide evidence for claims and arguments. Here, the lack of need for logical evidence may further aggravate this impaired communication modality.

BLOCKING

A frequently observed phenomenon in culturally deprived children is the polarity between acting-out, agitated, unplanned, impulsive behavior, and quasi-total blockage of responses. This blocking often follows a prolonged trial-and-error activity that results in failure. Blocking may range from a lack of initiation of new responses to an open avoidance of encounter with stimuli that may place the individual in a position to react. Blocking, in this context, must be considered as a response to cognitive failure, affecting the readiness of the organism to enter again into an endeavor that may lead to failure.

This behavior requires an understanding beyond the motivational aspect to which it is usually attributed. It seems to resemble somewhat the reaction found in Pavlovian conditioning experiments during which blocking reactions were observed in response to ambiguous stimuli.

TRIAL-AND-ERROR RESPONSES

Trial-and-error behavior is often suggested as an efficient means to teach the child rules and principles through discovery, as opposed to ready-made responses or imitative reproductive types of learning. This is certainly true for the learner who, by virtue of his mastery of the prerequisites of cognitive processes such as precise perception, comparing, summation, reflective thinking, and an orientation to search for causal relationships, can relate the obtained effects of his behavior to the specific antecedent behaviors that have produced them. However, the fact that the culturally deprived child is deficient in these very functions disables him from making proper use of the experiences offered to him by trial and error. The sequence in which events occur, their order in space, and their quantitative or qualitative dimensions, even if observed, are not related to the outcome, its quality, its property, its nature, and its location. To a certain extent, then, exposure to, or encouragement of, trial-and-error learning may actually reinforce a kind of probabilistic, random behavior, diverting the attention of the individual and distracting him from the relationships to be discovered. This is consonant with our definition of the culturally deprived as an individual seldom sufficiently modified by direct exposure to sources of stimuli, irrespective of whether they are only perceived or whether they are acted upon. Trial-and-error behavior is, from this point of view, a typical situation in which direct exposure is the prevalent mode of interaction between the child and the environment. The environment *per se* is not structured to elicit appropriate and adaptive responses that enable the child to focus on the relationship of one specific behavior directed toward achievement of a desired outcome, as compared with other less adaptive behaviors. Thus, trial and error in a child who cannot, on his own, systematize his search for a goal, or who does not always conserve the goal he has set for himself, will of necessity be of limited value in establishing the relationship between his response and its outcome.

In many instances in which trial-and-error behavior has been used as a training procedure, rather limited results have been obtained, and, in certain cases, a slowdown of training may be observed. The same is true when the nature of the materials and the structure of the task, which the child is asked to act upon, involve him in trial-and-error behavior. Such conditions reduce significantly the capacity of the child to deduce the rules and their application to new situations. Knowing the propensity of the culturally deprived child to acting out, trial-and-error behavior should be discouraged until the corrected cognitive functions will permit him to benefit from this activity.

DEFICIENCY OF VISUAL TRANSPORT

Deficiency of visual transport is defined as the incapacity of the retarded performer to complete a given figure by visually transporting a missing part from a given distance or by choosing the complementary missing part from a number of alternatives. That the difficulty is engendered by the visual transport of data from a given distance to the place where they belong is evidenced by the fact that the same child often succeeds in the task when his response involves a visual-motor gesture, such as drawing the completed figure in the air with his finger, or even when his response entails a graphic presentation of the completed figure. It seems that, in transporting the missing part visually, something is lost on the way, and, therefore, an inappropriately oriented figure is chosen (often after the task has been successfully completed through motor or even verbal modalities). It is known that difficulty in visual transport is observed in normally developing individuals when complexity is increased by factors surrounding perceptual elements that make a discrimination between them difficult. Thus, in a task in which the response must be made on a control panel, identical to that on which the stimulus was presented, the individual is likely to produce more errors than when reacting to the stimulus on the original panel.

In the culturally deprived child, two factors often seem to be involved in the experienced difficulty in visual transport. One is an instability of the perception itself, attributable to the vulnerable nature of the systems of reference supporting the perceived elements. The second relates to the narrowness of the mental field as the child becomes diverted by his encounter with irrelevant data, once his eyes stray from the source of the data to other sources of information. Consequently, he fails to conserve the image which he has formed and which was the original object of his search.

EPISODIC GRASP OF REALITY

A common thread running through virtually all of the above-described deficient functions is the phenomenon that we refer to as an episodic grasp of reality. Occupying a central position in our conception of deficient functions, it represents both a cognitive modality of interaction with reality and an energetic principle that determines the nature of the interaction. Episodic grasp of reality is, therefore, a bridge between the cognitive and affective-attitudinal determinants of behavior.

In essence, grasping the world episodically means that each object or event is experienced in isolation without any attempt to relate or link it to previous or anticipated experiences in space and time. An episodic grasp of reality reflects a passive attitude toward one's experiences because no attempt is made by the individual to actively contribute to his experience by organizing, ordering, summating, or comparing events and thereby placing them within a broader and more meaningful context. In this respect, the affective energetic principle is important because the organizational activity of the organism is, at least in its early stages, a product of a volitional, intentional, and purposeful effort on the part of the individual. This is in contrast to the more elementary cognitive processes, such as identification, recognition, association, and even reproduction, which do not necessarily rely for their adequate functioning on a purposeful and intentional orientation of the organism. Thus, an episodic grasp of reality is related to deficiencies in extrinsic and intrinsic need systems of the individual that render the active organization of information unnecessary and uneconomical.

As an umbrella concept, episodic grasp of reality must be understood as being determined by and, at the same time, determining many of the deficient functions previously discussed. Grasping an event episodically reduces it to vague and undefined dimensions with little relation of its most relevant characteristics to other events that have preceded and that may follow. A lack of comparative behavior, which epitomizes an episodic grasp of reality, limits our experiences to unique and unconnected events closely tied to the concrete here and now. Similarly, a lack of grouping or summative behavior confines our experiences of the world to more concrete sensorimotor modalities. In contrast, when organizing and linking activities occur, the individual is forced to detach himself from direct sensorial experiences and to accede to levels of abstraction and conceptualization. It is only when reality needs to be represented, in order to categorize and establish relationships between objects and events, that the need for encoding information arises.

The passivity of the individual, reflected in an episodic grasp of reality, influences his self-image as a recipient rather than a generator of information. Generating information is, of necessity, contingent upon the need of the individual to bring together facts, to compare, re-evoke, order, re-order, group, and re-group objects and events that are remote in space and time. An

episodic grasp of reality is also responsible for the limited readiness of the individual to respond to incompatibilities in the field that provide the basis for the recognition of the existence of a problem. This passive approach is often characteristic of the culturally deprived child, and, when asked to establish relationships between objects, his reaction will be one of surprise or resistance.

The propensity to contribute to one's interaction with the environment and experience of the world goes beyond that required by our biological needs. The development of the need to create order, to make sense of, and to provide meaning for our experiences is inconceivable without mediated learning experience. Very often, the behavior attributed to the retarded performer is an expression of his episodic grasp of reality, which is manifested in his failure to act on and go beyond the mere registration of incoming stimuli and information. In terms of our approach, any attempt to modify a child must involve a fundamental reorientation of his encounter with reality. What is required is a change from a passive episodic grasp of reality to an active mode of interacting with the environment by operating on and transforming experiences and, thereby, detaching oneself from the constraints and limits imposed by the sheer sensorial perception of the world.

Appendix 1B Examples of the Instrumental Enrichment materials

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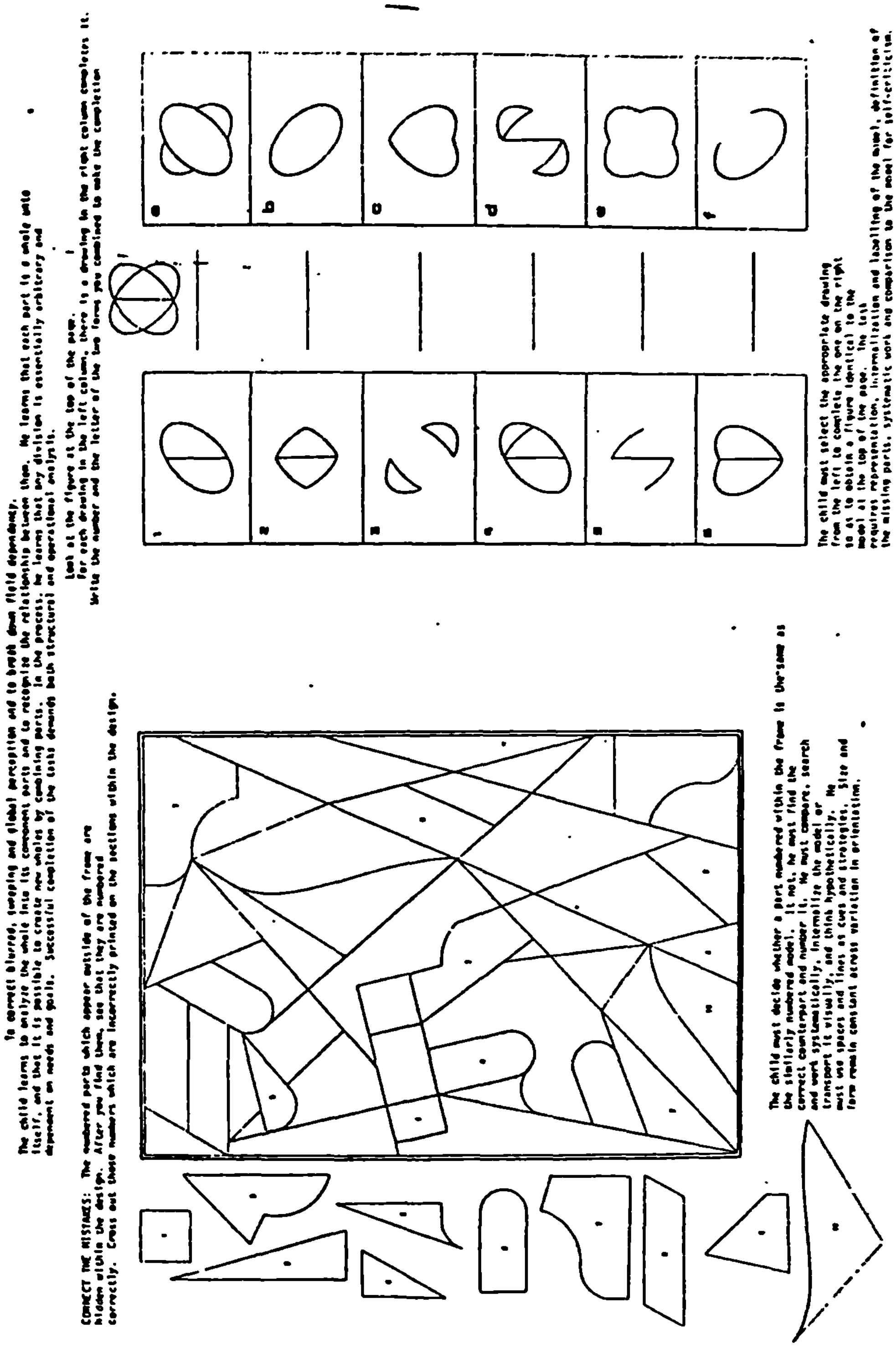
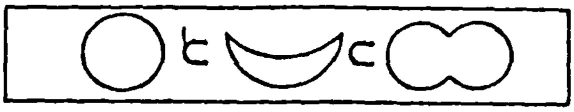
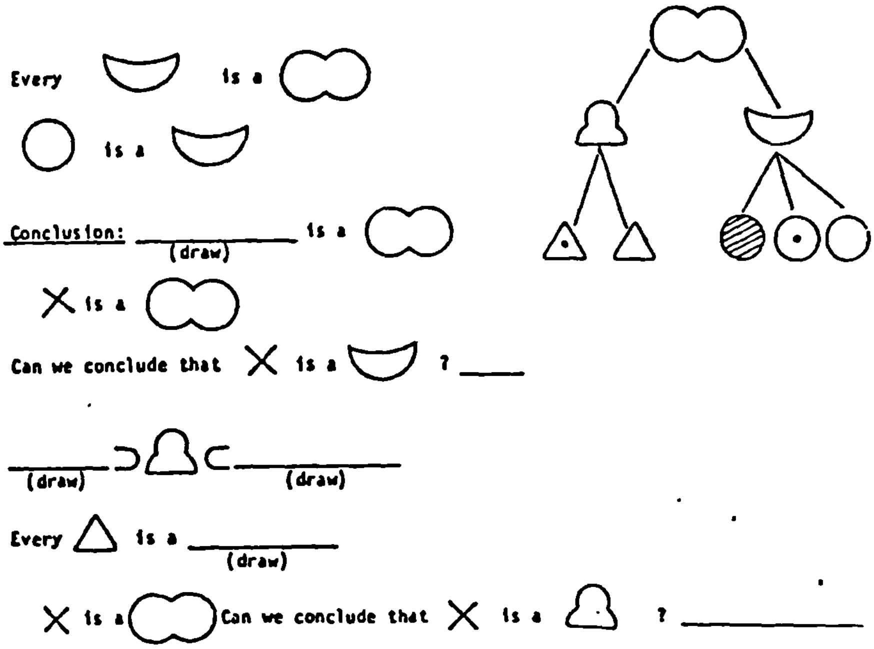


Examples from analytic perception.

(Feuerstein et al. 1981)

In this instrument, the student learns to use formal logic. He distinguishes between identical sets, subsets, and intersecting sets, and then applies what he has learned in order to arrive at conclusions regarding validity and truth. Using the relationship between two statements and its implications, he is able to infer the validity of a third statement. In these exercises, he uses the Venn diagram to encode his information. Thought becomes abstract and not based on verbal meaning, but rather on the form and structure of the given statements.



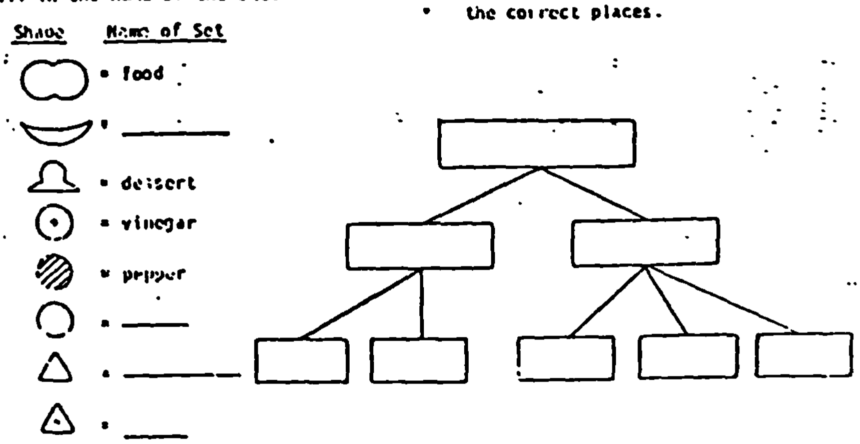


Each one of the above shapes represents a set. Every set has a name.

The names of the sets are: salt, spices, food, ice-cream, dessert, cake, pepper, vinegar.

Fill in the name of the set.

Fill in the names of the sets in the correct places.



Logico-verbal reasoning becomes highly abstract. Meaning is based on the rules which have been acquired regarding members of sets and sub-sets. The task involves encoding and decoding, use of signs, finding relationships, discovering the priciple upon which categories have been formed, choosing and processing relevant data and thinking logically.

Examples from syllogisms.

(Feuerstein et al. 1981 p.277)

DESCRIPTION OF INSTRUMENTS 235

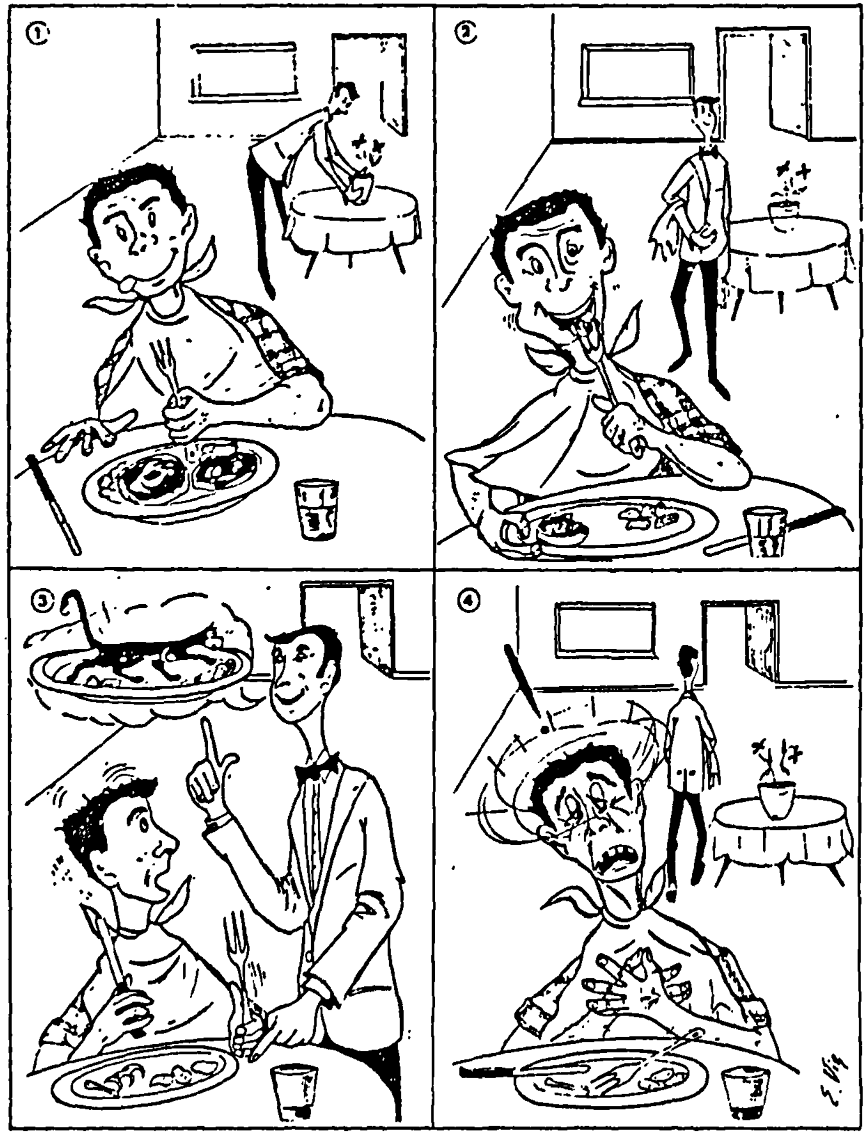
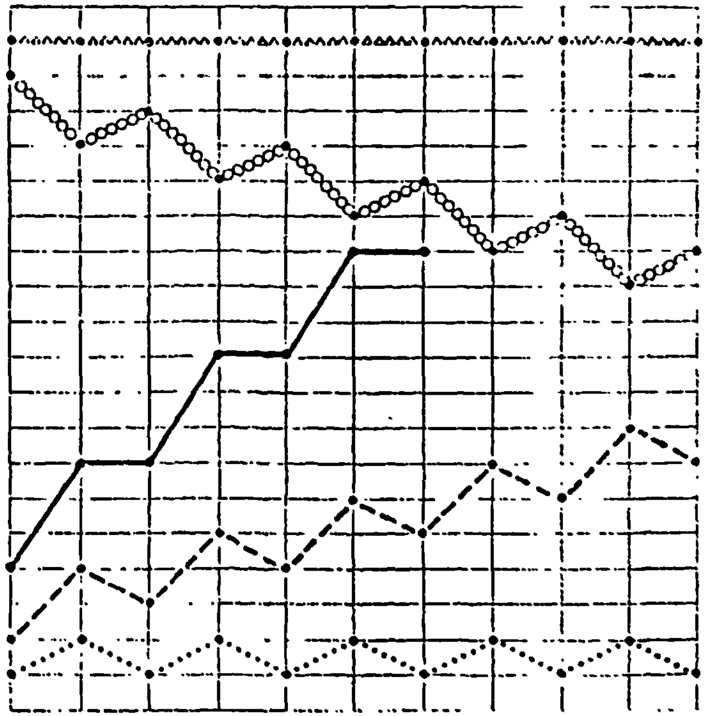


Figure 17. *Illustrations* (page 13).

Below is a grid with a number of plottings. Each plotting corresponds to a relationship which exists in a progression of numbers which appears at the bottom of the page. There is no relationship between the plottings.



Draw a line to connect the progression to the drawing by which it is illustrated on the grid (see example below).

A 8, 6, 7, 5, 6, 4, 5, 3, 4

B 21, 23, 22, 24, 23, 25, 24, 26, 25

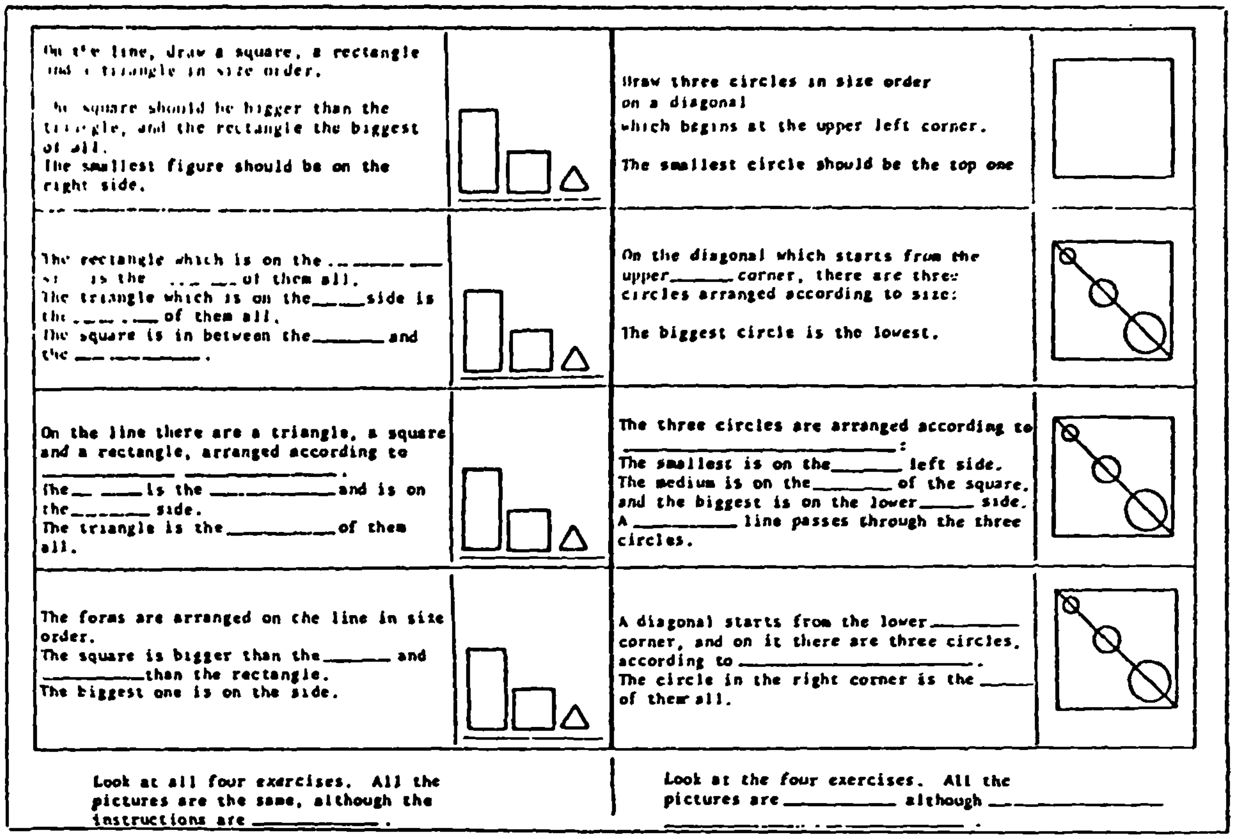
C 20, 23, 23, 26, 26, 29, 29

D 39, 39, 39, 39, 39, 39, 39, 39

E 17, 18, 17, 18, 17, 18, 17, 18

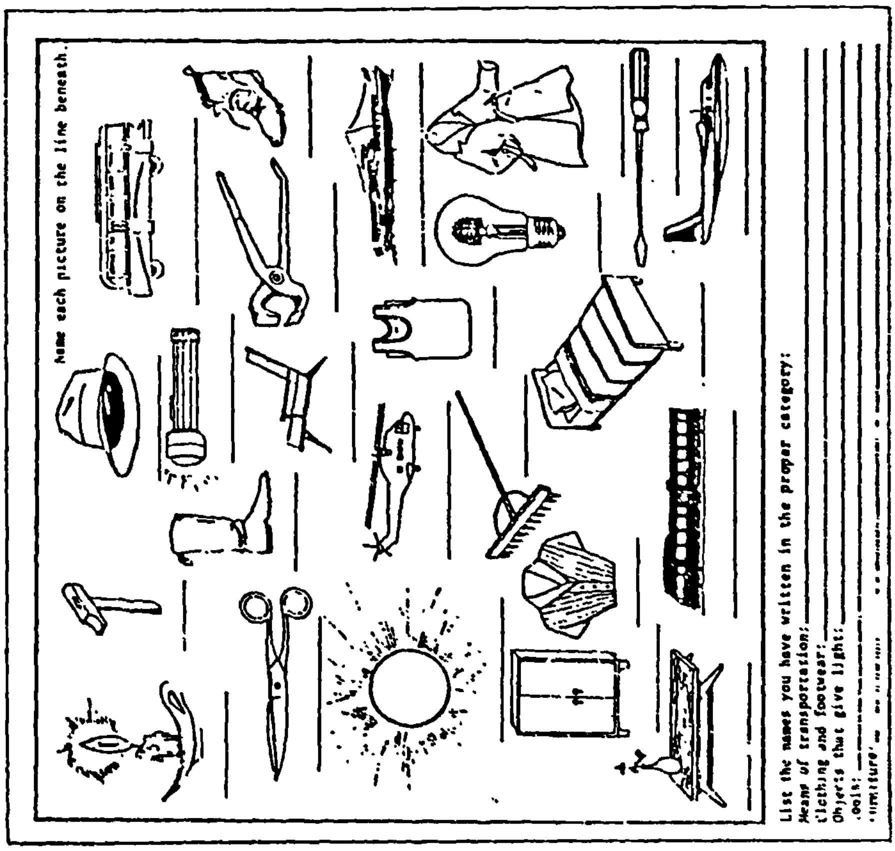
Figure 12. *Numerical Progressions.* An exercise from the unit on graphing.

(Feuerstein 1980, p.235 & p.217)



Instructions (page 12).

(Feuerstein 1980 p.177 & p.228)



Categorization (page 6). In order to assign membership to classes, it is necessary to be familiar with the invariant attributes of the given categories: it is important that the students gain insight into the underlying commonalities between objects that seem to be very different. Because the given sets are very distant from one another, there is little chance for error in attribution. There are difficulties, however, in labeling, in systematic work, and in using the two or more sources of information.

Reprinted from: Feuerstein (1980, pp289-291)
Instrumental Enrichment
University Park Press. Baltimore.

APPENDIX 1C

SUMMARY OF CHARACTERISTICS OF INSTRUMENTAL ENRICHMENT

I. 1. Instrumental Enrichment is based on a systematic utilization of functions that are the prerequisites of proper cognitive operations. Each instrument focuses on a specific cognitive function, but simultaneously addresses itself to the correction of many others that may be deficient.

I. 2. Instrumental Enrichment involves the cognitive operations considered as the components of adequate cognitive functioning. These are of varying levels of complexity and novelty.

I. 3. Instrumental Enrichment assigns tasks to the learner that require from him the use of higher mental processes. Even though there are exercises in the instrument that involve more elementary cognitive processes, they are prerequisites for, rather than the essential goal of, the activity.

I. 4. Instrumental Enrichment places stress on the development of intrinsic motivation through formation of habits by manifold and varied repetition of the different target functions. However, the emphasis of the repetition is not on the tasks themselves, but on the function that is invariant within the divergent activities elicited by the task. This facilitates flexibility, shift, and transfer.

I. 5. Instrumental Enrichment attempts to elicit two distinct types of motivation. The first is task-intrinsic. Tasks are shaped in a way that makes them a target for curiosity and arouses a need in the learner for active mastery, a need which increases with the progressive complexity of a task. Success at earlier levels engenders a potent need to cope with and master the more difficult tasks.

The second type of motivation is the reinforcement of the social meaning of the task. There is a need to achieve not only in relation to the peer group but in relation to the teacher as well. The teacher in Instrumental Enrichment shares more of a partnership relationship with the student than in most other instructional interactions.

Both types of motivation are fostered by the challenge presented by the tasks, which are genuinely difficult, even for an experienced and achieving adult.

II. 1. Instrumental Enrichment is designed as a content-free set of tasks, in the sense that the content of an instrument does not serve as its goal *per se* but is, instead, a carrier for the more direct goals of the instrument. Content is not chosen by virtue of its specificity, but because its special characteristics permit the acquisition of the prerequisites of thinking.

II. 2. Despite its deliberate content-free design, Instrumental Enrichment provides for easy bridging to specific subject-matter areas because its dimensions are those necessary for content learning. Such bridging is enhanced by the activity of the teacher whose goal is to produce insight in the student.

II. 3. Instrumental Enrichment is designed to stress the nature, structure, and complexity of the tasks themselves and the effects produced through the child's confrontation with them. Its structure ensures the attainment of the majority of the program's subgoals. The efficiency of FIE is highly enhanced, however, by the mediation of a well trained teacher.

III. 1. Instrumental Enrichment implies a level of consciousness and awareness of the partners involved in the training process: teacher-student-material. This awareness involves both the global goal of Instrumental Enrichment and the specific meanings of each task for the development of efficient use of cognitive processes and adaptation to new situations, in general.

III. 2. For performing its tasks, Instrumental Enrichment includes and requires a variety of transformational, elaborational processes, with the performer actively contributing to the organization and restructuring, and the discovery and reapplication of the produced relationships. Mastery of the tasks in Instrumental Enrichment is never a matter of rote learning or the mere reproduction of a learned skill. Accomplishment of the tasks always involves the learning of rules, principles, or strategies underlying the task, rather than the task itself.

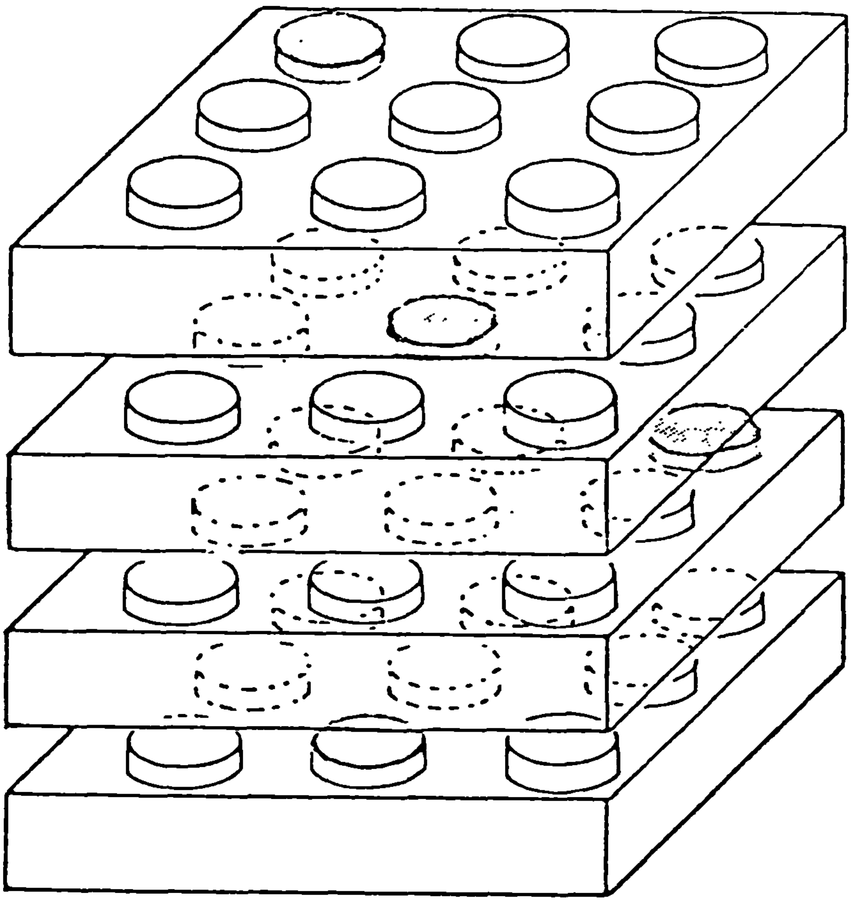
III. 3. Instrumental Enrichment materials are constructed to produce the conditions of a responsive environment. As such, the materials elicit in the student a need for mastery of the task with the criteria for mastery established by the materials themselves; and thus, feedback is built into the tasks and the student is constantly informed of his performance.

III. 4. Instrumental Enrichment is accessible to, and useful for, a wide range of populations in terms of levels, ages, and skills. Its content-free nature, and the progressive difficulty and challenge of its tasks, make it appropriate for all cases in which improvement in cognitive functioning is sought. Of particular importance is that it avoids stigmatizing, or reinforcing a low self-image in, individuals who engage

in the program by avoiding the frequent practice of simplifying "normal" curricula to accommodate lower levels of functioning.

IV. 1. The principles and didactics of Instrumental Enrichment are useful in changing the attitudes and techniques of educators, psychologists, social workers, and counselors toward the target populations. The methodology of Instrumental Enrichment is transferable to other subject matter and treatment areas.

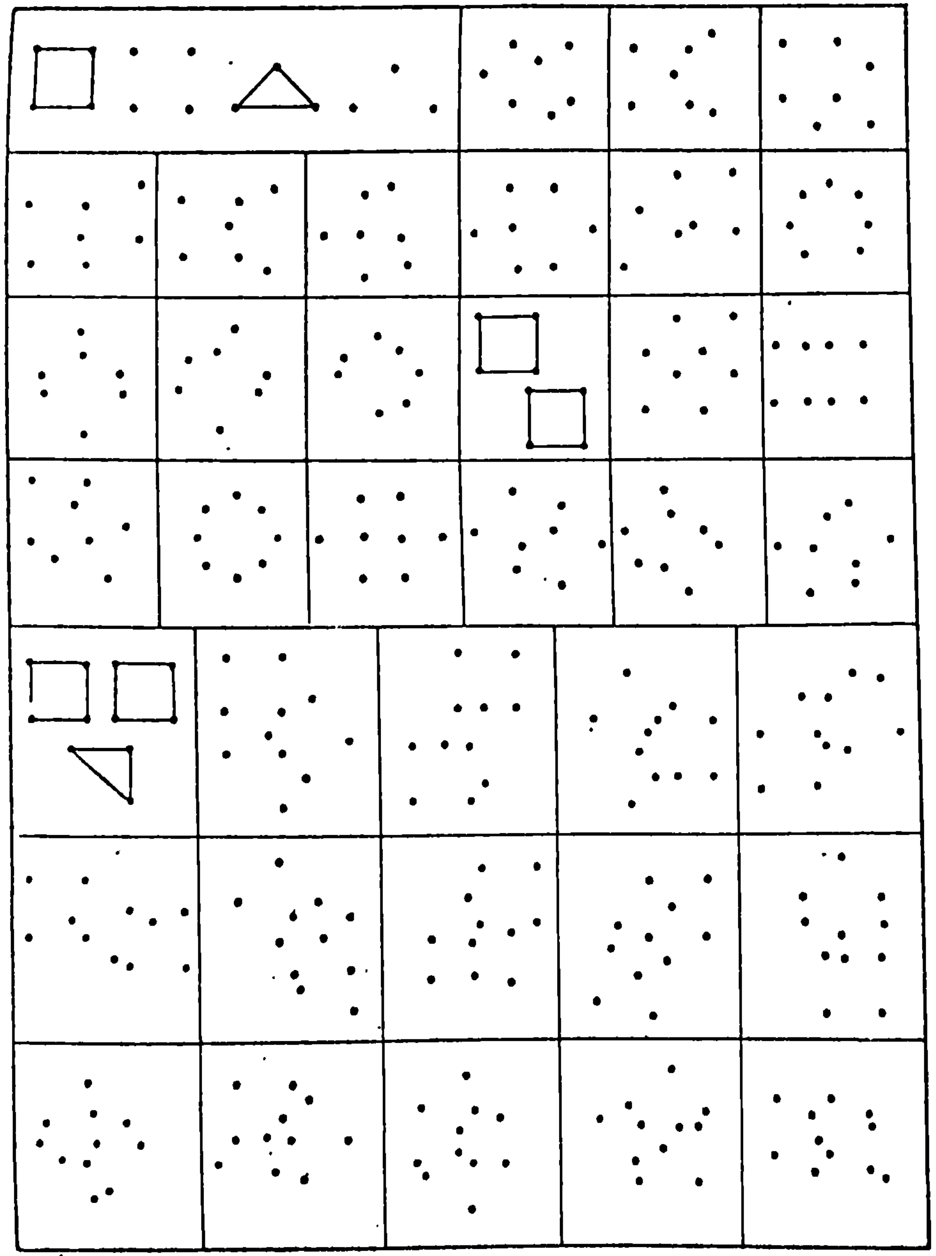
APPENDIX 1D Examples of LPAD test materials



Plateaux Test.

(The subject has to locate the fixed button on each of four plates and remember their position once the stack is rotated, first through 90 degrees and then 180. The test may be made harder by introducing two fixed buttons per plate).

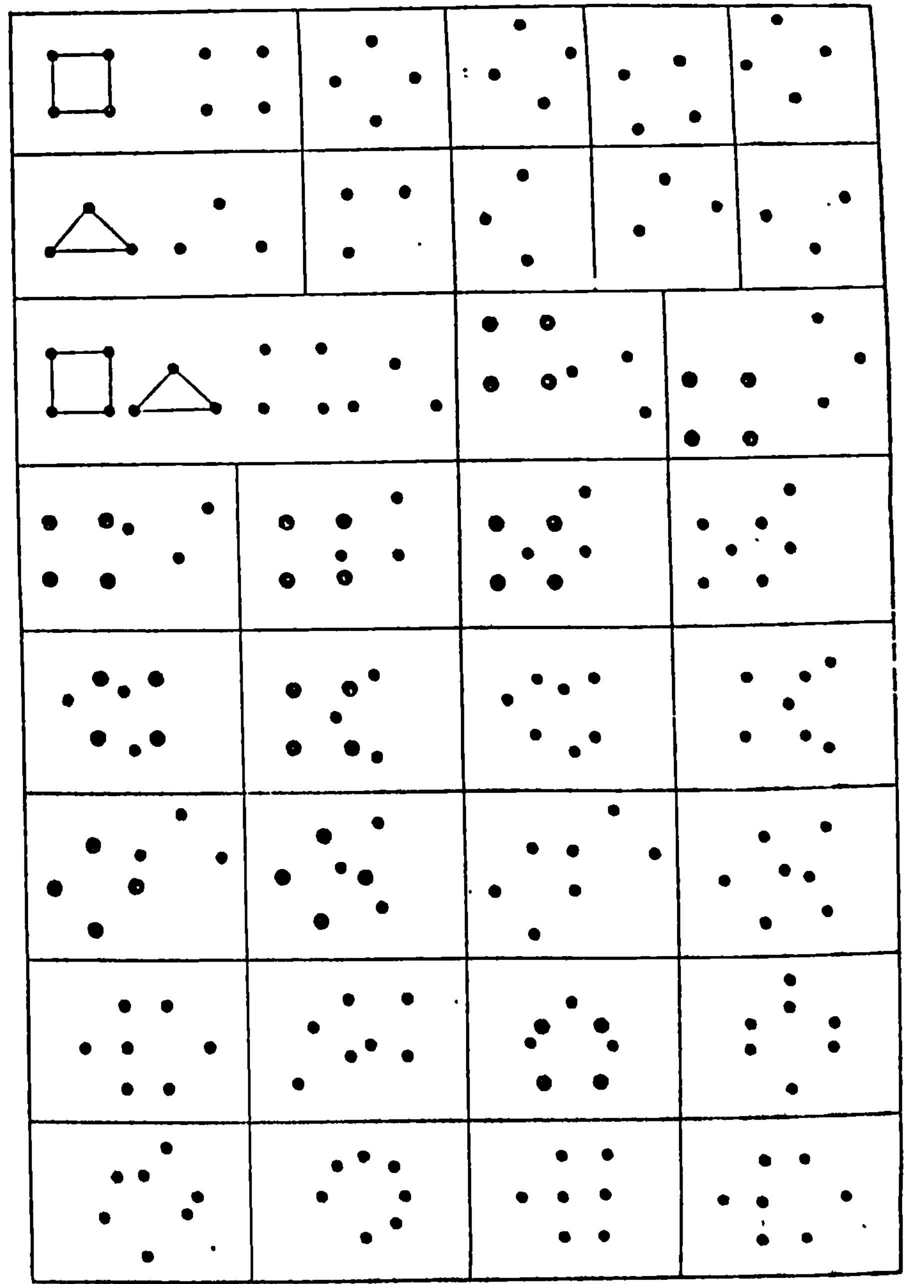
תאריך: מקום: Organization of Dots תאריך: מקום:



א.נ/בז

Organisation de points d'A.REY
Diffusion Limité Pour But de Recherches.

ארגון נקודות



א.נ.ל/1

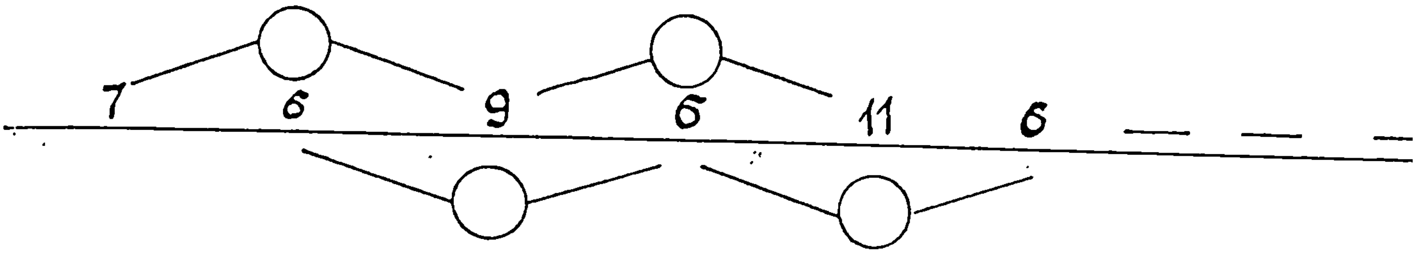
L.P.A.D. Training test.

ארגון נקודות

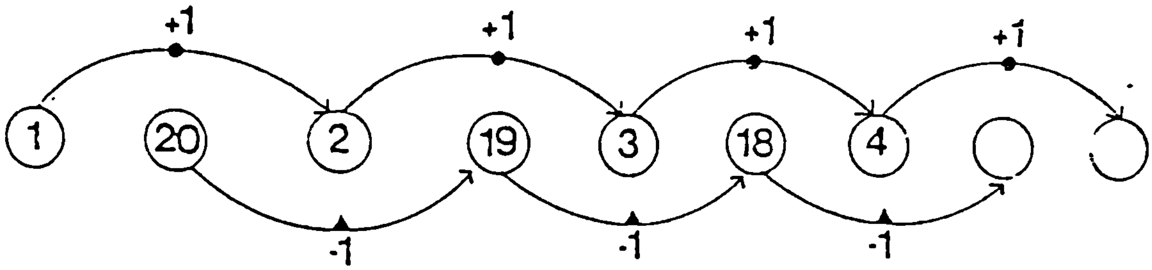
Examples from Numerical Progressions.

21. 9 7 3 7 9 3 9 7 3 ___ ___ ___

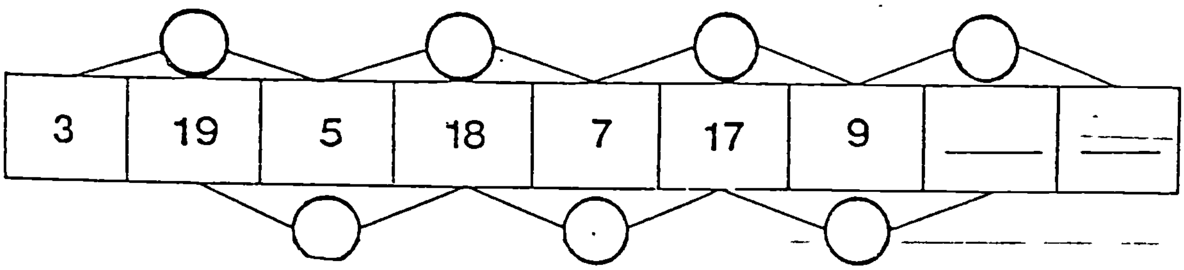
22.



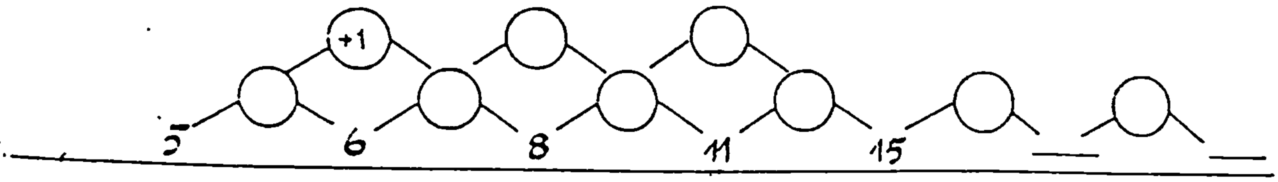
5



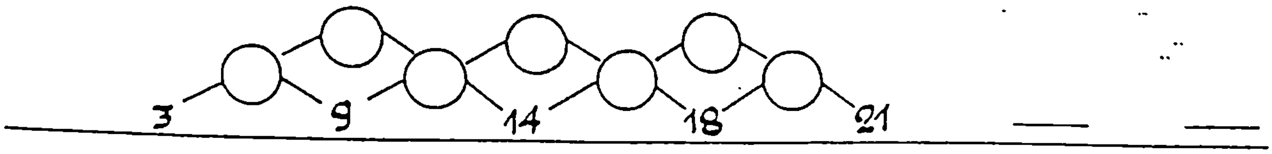
6



28.

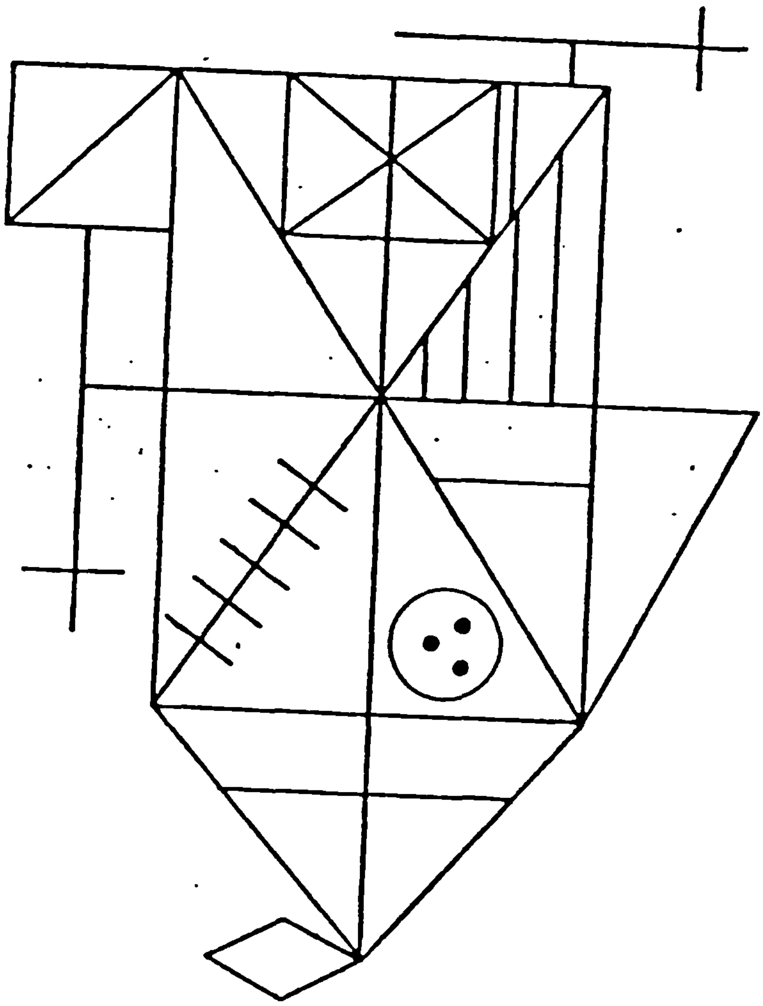


29.



30. 4 8 13 19 26 ___ ___

Rey Complex Figure.



The Complex figure test consists of a complex geometric figure with both internal and external details,(18 elements).The subject is asked to reproduce the figure from the stimulus model and after a latency period, to reproduce it from memory.After the examiner provides appropriate mediation for the correct drawing of the figure, the subject is required to repeat his attempt to draw the model from memory.

Appendix 2A : Reports of LPAD test sessions

Report 1: Andrew (Age 12) First visit 17/2/1982

Andrew had considerable difficulty with the Organisation of Dots (OD) problems. It took us a long time to establish a descriptive language which we could use to compare the squares, triangles and other geometric shapes. I asked him what he thought the difference was between a square and a rectangle and he thought they were the same. It required a lot of discussion before he was able to isolate the properties of a square. When he drew in the shapes he persisted in drawing a rectangle and he needed reminding continually of the rules we had talked about. I taught him how to judge the distances between the dots as a guide to suitable line length and he was able to utilise this strategy in finding the shapes, although only when it was initiated by me. He was only able to use line length, and not angle size, as an efficient cue, and this lack of awareness of angles prevented him from being able to 'project' a fourth dot when he already had the other three. Occasionally he forgot to close one of the sides of the shape. We spent about 40 minutes on the training sheet of OD and only completed a random selection. However, he managed to recognise squares and triangles in different orientations so there was no lack of 'conservation' there. He drew his figures carefully and well and he did not resort to 'trial and error' behaviour although he occasionally 'blocked'.

Next we tackled the A and AB series of Raven's Coloured Progressive Matrices. Andrew scored 8 correct with a further 1 that he spontaneously corrected (SpC). On the AB items he got 9 correct and 1 SpC. These problems took about 20 minutes to solve despite being the easiest in the series. This puts him well below average for his age. On item A7 he chose alternative 1 which is an indication of an 'inability to use two sources of information' simultaneously. On A10 he saw that the 'arrow heads' needed to be horizontal but forgot to attend to the direction of their points and he needed prompting to do so. Items A11 and A 12 also proved difficult. On A11 he first chose alternative one which indicates a 'blurred and sweeping perception' and since he was unable to correct himself I taught him how to trace out the solution using the lines already provided in the figure. His difficulties may also reflect an 'inability to use two sources of information' or inadequate 'problem definition'. Item A12 presented similar problems and the solution took about 5 minutes to explain. On the AB series item 9 strongly highlighted Andrew's verbal defits: he was unable to use simple relational terms like left and right. We also spent a long time on AB12 and once again he failed to appreciate that more than one transformation could occur in the matrix at the same time.

To his credit he was quite systematic in his search for the solutions; he would first try and define the requirements and then he would look for them amongst the alternatives provided. This strategy would be extremely productive if he was first able to pinpoint ALL the salient features of the problem.

Andrew was an extremely pleasant child who responded well to this type of informal test situation. He worked slowly but he did make gains over the brief test session : by the end of OD he was begining to test out the distances between the dots (although not yet efficiently) and on the Raven's item AB11 he traced out the solution without any prompting. Language seems to be the origin of many of his problems : he has few appropriate labels or systems of categorisation and this impairs his 'use of logic' and 'comparative behaviour'. He also exhibited deficits in the output phase by 'blocking'.

It is essential to find out whether his inability to process 'two sources of information' is a matter of oversight or a real limitation in the number of units of information that he can simultaneously process,(or 'narrowness of mental field'). I recommend that the Plateaux test be used to find this out and an Associated Picture Recall test as a means of investigating his language problems. Andrew would be a good candidate for the Instrumental Enrichment training group.

Report 2 : Andrew, second visit 4/3/1982

Andrew found the Plateaux test extremely difficult. It took him 16 attempts to find the location of the button on the first plate, (there are only 9 buttons), and obviously he tried some buttons more than once. This is a demonstration of 'narrowness of the mental field'. It also shows that he is not systematic in his search strategy: I asked him to point to the ones that he had not already chosen and he was unable to differentiate between them. However, he was able to learn the 2nd, 3rd and 4th plates without repeating his choices. On the first trial he located the buttons with only one mistake, on the second he made 7 and on the third he made 13 and so on. Obviously he was unable to use the information he had learnt in previous trials to help in his search. He took seven trials in all before he could locate the buttons on all four plates without error and even then it was with continual reminders :'Where was the last one?', 'so where will the next one be?'. I tried to teach him to use words as orientational cues (left, right, top, bottom and middle) but he was unable to make use of this and continued to see the plates in isolation.

In phase 2 of the Plateaux the subject is required to transform the location of the buttons onto a two dimensional map, laid out in exactly the same format as the Plateaux. Andrew could only draw in the location of the first button. He lacked the ability to use 'symbolic representation' to help him draw the map and even when the map was complete he was unable to use it to his advantage on subsequent tasks. I rotated the plates by 90 degrees and asked him to find the buttons again. This was very hard for him; he got the first plate but the second took five attempts. He had no concept of 'spatial orientation' and it was necessary for me to point out, both verbally and with gestures, what had happened. Again he was unable to use the verbal cues I gave him and demonstrated further signs of a limited memory span ('narrowness of mental field'). We did not complete the 90 degrees rotation but as he seemed to feel he was succeeding I decided to leave it at that. One thing I noticed about his search strategy was that he tended to look in the same place for a button as the one where he had just been successful on the previous plate. It took us 35 - 40 minutes to get this far.

The Associated Picture Recall took 10 minutes to complete. Andrew could name all 20 items. In the first stage of abstraction he was only reminded of one item, in the second stage he was reminded of 9 items but on the final recall he obtained 19/20 correct. To some extent therefore he has the ability to use abstract symbols.

In the last 10 minutes of the interview I tried Andrew on some of the Numerical Progressions sequences. This was quickly abandoned since he has absolutely no concept of number sequence at all. The first problem required him to continue the sequence 9.10.11.12.13.14... which he could do by counting and not by realising that the numbers increase by one. I asked him what he had done but he could not tell me. On the next sequence the problem was 23.22.21... and he told me the next number would be 23 then 29. I asked him if 22 was bigger than 29 and he said yes. He was unable to count backwards. The rest of the session was spent doing elementary number counting, although not with success. He was unable to apply any operations to the numbers, not even addition.

Andrew appears to have difficulties in all the phases of thinking. A number of things point to 'elaborational' problems : his extremely restricted performance on the Plateaux and on the Numerical Progression. He appeared to see each event in isolation to the last, that is there was no 'learning' carried over. Feuerstein would interpret this as an indication of an 'episodic grasp of reality'.

<u>Report 3</u> : <u>Shaun (Age 11/12) First visit 17/2/1982</u>

Shaun was given the Organisation of Dots (OD) training sheet of which he completed 10 in a matter of minutes. An initial difficulty arose when he was asked to define the properties of a square. In respose to his answer 'four sides' I drew a rectangle which he thought was like 'two squares'. I then drew an exaggerated oblong to demonstrate the difference in the length of the sides. He did not know the concept of rightangle but we agreed that a square had four square angles and that a triangle had one square angle as well as two sharp angles. As he had no difficulty in 'projecting' these shapes even when they were rotated or overlapped, we moved on to the test page. He took about 10 seconds / frame for the square and triangle. When the square was standing on its point (like a diamond) he would rotate the page until its base was flat to the table's edge. When three shapes were involved he did need to be reminded to use efficient strategies such as always looking for the square first or to look for four dots that were equally far apart. These frames only took about 30 seconds each to complete.

On the Raven's A series he scored 11/12 correct and 1 spontaneously correct (SpC), on the B series he scored 9 correct and on C he scored 10 correct and 1 SpC.This puts him above average.

I asked him how many dots would be necessary to make the pattern in A4 complete and he aswered correctly without needing to count. He demonstrated a certain amount of 'impulsivity' : on A8 he only took account of one source of information (the horizontal line) and when I pointed out the vertical line he immediately switched his answer to included this feature without realising that both were necessary. When pressed, his logic behind his choice of answers was very good although he was a bit reluctant to describe why answers were correct.In general he found the tasks easy but when he came across harder problems he tended to resort to 'trial and error'. He was only systematic when the answers were easy.However, he was able to utilse the strategies provided to help him.

There is little doubt that Shaun is a bright boy and it was necessary to look sharply to find any 'deficits' at all. He did demonstrate a certain amount of 'impulsivity' and 'blurred and sweeping perception' on the Raven's items. I suggest we try him on LPAD 11 because these items are more exacting and will therefore be of greater value in his cognitive assessment; Shaun only performed with confidence when he was getting the items all right. I also suggest the Plateaux 11 which covers spatial relations, the use of internal images or representation, and impulsivity related problems. The tests covered today did not highlight any major difficulties. However, Feuerstein's model of cognitive deficiency is not confined to those who are under-achieving at a low level. Sometimes it is precisely because a child is bright or independent that he fails to engage in mediated learning experience with an adult.

Frances Beasley

Appendix 2B:

Use of Raven's Standard Progressive Matrices in conjunction with the LPAD Variations for estimating 'modifiability' (note from Dr M. Shayer)

Inspection of the published report on the Raven's (1981) standardisation shows that the bulk of the item discrimination curves showed that their steepest portions at around the 33% success mark. This means that, in relation to the overall test score, the sharpest cut-off point before total failure occurs is where the person's success rate has dropped to 33%. If it were possible to find this point in the test, it should be possible to cut short the administration at this point, and estimate a total score without making the subject attempt all the items.

Among the data published by Raven (junior) are Tables showing the item facilities of subjects obtaining overall test scores of 15,20,30 etc. These Tables were searched empirically for some way of locating the 33% cut-off mark, and then relating that to the total score. It was noticed first that although there are only six alternative answers to each item, so that the probability of getting an item right by chance should be 0.17, in fact the facilities fall rapidly to the 0.09 to 0.04 range. This indicates that among the 'distractors' there are some which are superficially more attractive than the right alternative. Therefore the relative allowance, in the estimate of total score, for the operation of chance success is rather small. With the items rearranged, where necessary, in order of item facility, the smoothing technique of taking a running mean facility of three items was adopted. The subject was credited with the ordinal number of items right corresponding to the middle of the three items where the facility had dropped the nearest to 0.33.Any previous failures were ignored, and set off against the other items that the subject might have got right by chance.

It was necessary to carry out this procedure seperately for the A,B,C,D and E groups (Series) of items, since although the item facilities decrease within each group and each group is harder than the previous, the facility ranges overlap considerably. The corresponding test procedure would be to take the subject through each of the groups successively, recording successes and failures within each group until the subject was getting less than one item in three right, and then move on to the next group. Table 1 (below) shows the results of using this estimation procedure on Raven's reported item facilities.

It can be seen that the estimation of total score, obtained by losing information from each item-group after the subjects cease to score at at least a third of the items right, is quite satisfactory, (Table 1). In addition the group estimated totals within the item-groups agrees within an error of one item* with the Tables first published in 1938 by Raven

*with the exception of the E items, where there were two cases where the reported successes were 2 greater than the above

(Senior) where the total score was broken down into items right in each group to the nearest whole number, (Raven 1960).

Table 1 : Test estimation procedure for Total score on Raven's SPM

Obtained total score	Estimated total score on groups using nearest 0.33 facility rule A	B	C	D	E	Estimated total score
15	8	4	2	1	0	15
20	10	5	3	1	0	19
30	11	7	6	6	0	30
40	12	11	9	9	1	42
50	12	12	10	10	6	50

Accordingly the test procedure adopted was this: for each item-group the subject was taken through until their success rate had dropped to less than one in three. They were then given the next group and the same procedure was adopted. The only exception was that if they had already succeeded on 9 items out of a group they were given all the items in that group, and their total score for the group was the number of successes. This procedure reduced to tolerable limits the subject's frustration. Afterwards the subject was given the LPAD Variations on which help (mediation) was available if necessary and the Raven's matrices were then administered for a second time: but only from the point where he or she had previously started to fail.

The scoring procedure was to score the subject at the ordinal number of the middle item where the success rate had dropped to one in three correct, for each group, and then the totals were added for each group to estimate the total score.

Thus it appears that one may modify the administration of Raven's SPM in the spirit of LPAD testing and still be able to use the Raven's norms to estimate the subject's performance level both before and after mediation on the LPAD Variations. The difference between the total scores on the two administrations of Raven's matrices (test and immediate re-test) provide an estimate of the subject's potential for change, that is his 'modifiability'.

APPENDIX 2 C : STANDARD QUESTIONS FOR THE LPAD VARIATIONS

AN Which is the answer?
A1 Describe what the piece will look like. (Cover the alternatives as a test of hypothetical thinking).
A2 Which one, why?
A3 Describe what the piece will look like.
A4 Why is it not alternative 1?
A5 - (No questions asked).
A6 -

BN Explain your answer. (Have they used 3 sources of information).
B1 Describe what the piece will look like.
B2 Which one, why?
B3 -
B4 -
B5 In which ways is alternative 2 wrong, how is it right?
B6 Why is this answer correct? (Have they learnt 'rotation' from B5).

CN Which is the answer? (Do they understand the change in the format from the A and B series?)
C1 Describe what the piece will look like.
C2 -
C3 Why is alternative 8 incorrect?
C4 -
C5 Which one? (Can they work with this novel format?)
C6 Describe what the piece will look like. (difficult to predict).

DN Why have you picked that one? (Have they spontaneously used all three sources of information ?)
D1 Describe what the piece will look like.
D2 Explain what happened in the matrix from left to right and from top to bottom.
D3 -
D4 -
D5 Which one? (Can they use 'rotation'?)
D6 Describe what the piece will look like.

EN Which one? (Difficult test of the use of three sources of information).
E1 -
E2 Describe what the piece will look like
E3 Explain your answer.
E4 -
E5 -
E6 This is the last one. Tell me exactly how you know this answer is correct.

APPENDIX 2D : ADMINISTRATION DETAILS FOR RSDT

First give the subject the page with the stencils on and ask them to name the colours, numbers and labels of the 'cut-out' shapes. Then ask the following questions to ensure they are aware of the format of the test.(* = stencils).

1) How are *10 and *11 different? (*11 has a circle cut-out).
2) If we put *11 on top of *7 what would you see? (Check on blurred and sweeping perception, also introduces the notion of superimposing the stencils).
3) What would you see if we put *2 on *10?
4) What would you see if we put *18 on *5?
5) What would you see if we put *5 on *18? (Reverse of above. Introduces idea that the order is important: If the base stencil goes on top it 'blocks-out' every thing underneath it).
6) What would you see if we put *12 on *10? (As they are both the same colour the stencils would merge).
7) What would happen if put *18 on *9.(Since *18 has a smaller aperture, we would see nothing of the red of *9 underneath: Importance of size.)

Training page

Give the subjects the page with the designs on, point to the first one and ask him which of the stencils we would need to make this design.
(The questions are given in order).
As a test of 'Visual transport' on a few of the questions the subject is given a sequence of stencils and asked if it would make the design in front of them:
Q.4 Is the answer *14 on *5? Why not, which is it?
Q.12 Is it *3 on *13?(yes).
Q.13 Is it *3 on *10? Why not, which is it?
Q.15 Is it *1 then *14 then *9? (yes)

(on Q.14 note if the subject spontaneously notes the introduction of a third stencil. On Q.18 note if the subject realises that the design has three stencils but only two colours).

Test page

The order of the test page corrosponds to my impression of the order of difficulty,(Q's 1.2.3.4.5.7.6.9.12.10.8.14. 11.13.15.16.17.18.19.20.). The items are grouped according to difficulty. After test Q.6,,(the first item that everybody attempts because of the different starting points),the subject must get the required number of items correct,(with a mediation score of less than 5) before he goes on to the next set of items:

The subject is told to start at question... "You have already done ones like these so we don't need to start at the begining of this page;

If the subject has succeeded on the 2 stencil training problems,(9.10 and 11.) with no help, miss out test items 1.2. and 3.

If 3/4 were correct on training items 14.15.16. and 17. (with a mediation level of less than 5 / question), then miss out test items 4.5. and 7. (3 stencils).

The training items can only be matched for difficulty as far as test question 7.
<u>On the test page</u>

2/3 correct, (with mediation levels less than 5) for questions 6.9. and 12, (3 stencils) needs to be achieved before attempting questions 10.8. and 14,(4 stencils). Of these 2/3 must be solved correct before attempting questions11.13.15.16. and 17,(5 stencils). Of these, 3/5 must be correct before attempting questions 18.19. and 20, (6 or 7 stencils). End.

Appendix 3A:
The Piagetian battery

NATIONAL INSTITUTE OF PSYCHOLOGY, ISLAMABAD

COGNITIVE DEVELOPMENT RESEARCH PROJECT

COGNITIVE DEVELOPMENT TASK BATTERY FOR PRIMARY SCHOOL CHILDREN

1. ONE TO ONE CORRESPONDENCE

MATERIAL:

24 wooden 1/2 inch cubic bloks; 12 red & 12 green.

PROCEDURE:

The subject is familiarized with the material. He/She is encouraged and helped to name the material and recognize two colours in the pile of 24 mixed up cubes. Then He/She is encouraged to separate piles of two colours and is asked to take the red pile.

Seven cubes from the green pile are taken up by the experimenter one by one and placed on the table in a line with a distance of 1 inch between each cube. The subject is asked to take as many red cubes from his pile as are the green ones so that there are equal number of red and green cubes. If the subject faces difficulty in arranging the initial equality he/she is encouraged and helped to the extent that initial equality is established.

After asking question about initial equality, the green line is piled up and questions are asked about the equality now. Then greens are again spreaded out in a line and red ones are piled and inquiry is made about the equality.

RULES FOR ASSESSMENT

I.A. The child is not able to put up the same number of cubes by himself, by placing one against one or by any other way AND does not qualify for any subsequent steps. However, if the child does qualify for any subsequent step, his failure at this stage will be ruled out.

I.B. The child is able to place seven cubes and accepts the equality of the set. If the child is not able to place the seven cubes by himself, but once the experimenter has helped him to do so, he now by himself accepts the equality of the two sets. BUT cannot give any reason for the equality. No conservation of number when the 1:1 correspondence is destroyed.

2: Recognizes initial equality of the set AND gives logical reason (correspondence or counting) BUT with the change in spatial configuration, the equality in number is destroyed. May maintain equality in some situations but not in all situations. May accept empirical reversibility (i.e. accepts that set will become equal when placed in 1:1 correspondence) I

3: Equality maintained in all situations WITH logical reasons. II

2. CONSERVATION OF LIQUID

MATERIAL:

Glassware consisting of one 500 cc beaker (C); two 250 cc beakers (BI & B2); Four 50 cc beaker (4D). One clear plastic bottle filled with coloured water.

PROCEDURE:

Equal amount of water is poured into BI & B2. After establishing the equality of BI & B2 the child is asked/to anticipate level of BI in C. Then transformation is done and questions are asked. Prior to all subsequent transformations, equality in BI & B2 is established. B2 is poured into A and then BI into 4D and inquary is made in all the transformations. Beside questions about "amount" inquiry is also made as to who will drink more liquid.

RULES FOR ASSESSMENT:

A: Level in C lower than B

B: Level in C equal to B

C: Level in C higher than B

1. No conservation. Amount varies with the change of container. If in some cases the verbal response is conserving, it is NOT supported with any logical reason.
2. Conserving in some situations and non-conserving in other. Conserving in 'drink' respons and non-conserving in 'amount' respons. Wherever the respons is conserving, it is supported by some logical reasons. I
3. Conservation in all situations supported with logical reasons. II

3. CONSERVATION OF WEIGHT

MATERIAL:

One small brass weighing scale, two plasticione balls of same size.

PROCEDURE:

The child is encouraged to talk about the use of scale for weighing. Identity of the weight of the two balls is established. prior to first transformation (sausages) the child is asked to anticipate its effect on the weight of the ball. The transformation takes place and subsequent inquiry is done. There are three transformations in the task i.e. sausages, pan-cake and six pieces and each transformation is preceded by establishing the equility.

RULES FOR ASSESSMENT

1. No conservation. Weight changes with eachtransformation.

2) Non-conservation in some transformations and conservation in some other supported with logical reasons. Lack of logical support in a conserving response will render it as non-conserving response. I

3. Conservation in all situations with logical reasons. II

4. SERIATION

MATERIAL:

Two sets of wooden sticks, all blue coloured and ¼ inch thick.

One set starting with one inch length and going up to 10 incjes with one inch intervals. (10 sticks).

Second set starting with 1½ inch length and going to 9½ inches length with one inch intervals. (9 sticks).

PROCEDURE:

Without showing to the child the way of picking up and starting with the smallest stick, a seriation is created on the table. The child is encouraged and helped to label it as stairs. Then the seriation is broken down and the child is asked to recreate it. If required the child's attention is drawn to the base line of series. After making inquiry about the selection of each stick the child is asked to insert the second set into the first one by handing over to him each stick in a random order.

Inquiry is made on his reason for placing each stick in a specific place. If the child's ability to seriate is not clear up to this point, both sets are removed and the child is given the sticks of the first set and is asked to hand over to the experimenter all the sticks one by one so that the experimenter could make the seriation behind the screen.

RULES FOR ASSESSMENT:

1. Fails to construct a single series. Constructs two or more small series e.g long sticks versus short sticks.

I Ignores base line completely and considers only tops or vice versa. Has difficulty in inserting additional sticks. Feels need to break previous series to insert new sticks.

2.A. Produces a more of less correct series by trial and error. Produces series without trial and error BUT cannot insert sticks correctly. I

2.B. Can hand over sticks correctly in the last trial despite difficulty in one or both of the first two parts of the task. II

3. Immediate success, starts with smallest (or largest) and systematically goes up (or down). No problem in inserting new sticks. III

5. WATER LEVEL

MATERIAL

Regeant Bottle-half filled with coloured water; Cloth mask for the bottle; Two sets of five sketches of empty bottle on a table in the following possition:-

(1) upright. (2) inverted (3) side wise (4) upright titled to right & (5) inverted titled to left.

PROCEDURE:

The child is familiarized with the material and is asked to show the level of water in the bottle by rounning his finger around the bottle on the water level.

then he/she is shown a sketch of empty bottle with a base live indicating the table. Then he/she is asked to show the water in the sketch of empty bottle by drawing a line in the bottle and placing a cross where he/she thinks the water is. Then one by one the bottle is moved to all the subsequent four positions and the child is asked to draw the level in the sketches in the similiar way. After completion of the first set of five sketches the bottle is masked with the cloth and the child is asked to draw the water line again. The bottle is moved each time in accordance with the subsequent sketches and the child is asked to draw in the same manner.

RULES FOR ASSESSMENT:

1. Water parallel to the base of bottle in all situations. No awareness of gravity. Base of bottle is the point of reference.
2. Some adjustment in the line of water with change in the position of the bottle. Water parallel to the base of the table in some situations but hot in all situations. I
3. Water line parallel to the base of the table in all situations. II

6.CONSERVATION OF VOLUME

MATERIAL:

Two 250 cc beakers; two rubber bands; two plastic-cine balls of same size (3/4 inch diameter); one steel ball fo same size; one clear plastic bottle filled with coloured water.

PROCEDURE:

After establishing equality of water in the beakers and the size of balls, the child is probed and helped to understand the process of displacement of water. Two rubber bands are wrapped around the beaker to indicate the present level of water. Then equality of displacement of water by the balls in two beakers is established. Prior to first transformation the child is asked to anticipate the effect of rolling the ball into sausage on the relative displacement of water in the beakers.

The subsequent two transformations (pan-cake and 6 small pieces) are done.Prior to each transformation,equality is re-established. After each transformation inquiry is made on the equality of displacement. At the end of inquiry on two Plasticine balls the child is asked to take in his/her hands one plasticine and the steel ball so that he/she could feel the relative differènce of the weight. Then equality in the size of two is established. Now questions are asked on the relative dispacement of water by the steel ball.

RULES FOR ASSESSMENT:

1. No conservation in any situation.
2.A. Conservation in some situations with logical support but non-conserving in some other situations (involving plasticine balls only).
2.B. Consistently conserving responses with reasoning on equality of weight. I
3. Conservation in all situations involving the plasticine balls with logical reason but not in the metal ball.
4. Conservation in all plasticine situations and also in metal ball situation. Success in metal ball will not be treated as success unless it is preceeded by success in all the plasticine situations. II

7.CONSERVATION OF AREA

MATERIAL:

Two 12 X 14 inch green plywood boards (grass field); 20 small toy houses; two toy cattle; two toy persons.

PROCEDURE:

After introducing the material and establishing equality of grass in the field, one house is placed in a croner of one field and if needed child is helped to realise that building of a house in the field reduces the area of grass in it. Then another house is placed in centre of the second field. Now the child is asked questions about the equality of grass area in the two fields. Then one by one, corresponding a house for a house, five houses are placed in a corner and in a straight line in one field and five in the other field scattered all over the field. Questions are asked about equality of area of grass now. Then five more houses in each field are added in the similar manner thus making ten houses in each field and questions about equality are asked for the third time.

RULES FOR ASSESSMENT:

1.A. One house built does not effect the total area.
1.B. No understanding of the concept.
2. Concept in some situations supported by reference to number and size of the houses but not carried to all situations. I
3. Clear understanding of concept in all situations supported by logical reasons. II

8. CONSERVATION OF LENGTH:

MATERIAL:

Two stick of ½" cubic cross section and 12 inches length. Two toy dolls.

PROCEDURE:

Both the sticks are placed before the child, parallel to each other. Equality of length is established. Top stick is moved about four inches to the right of child and questions about equality of two are asked. Then two dolls are made to walk on the displaced sticks from right to left and the child is asked as which doll covered more distance. Now the dolls are made to walk back from left to right and the question is repeated. Top stick is brought back to original positions and after establishing equality again, it is moved about four inches to right of the child and the same procedure is repeated. Top stick is again brought back to original position and now top is moved about two inches to the left and bottom stick is moved about two inches to the right. The same procedure is repeated again.

RULES FOR ASSESSMENT:

1. No conservation in lenght or walking-distance. Length is equal only when both ends of the stheis coincide with each other.
2. Conservation in some situations supported with logical reasons but no conservation in some other situation (length and walking-distance). I

3. Conservation in all situations supported by logical reasons. II

9.CLASSIFICATION

MATERIAL:

18 wooden chips of two sizes (large small) three clours (Red,Green and Bule) and three shapes (circle , square and tringle).

After familiarizing the child with the material he/she is asked to put together those which are alike. If the child starts with clour or shape he is encouraged to make three piles. After first attempt at classification, the classification is destroyed and he/she is asked to make another attempt with a different criterion. On child's disability to do so spontaneously, he/she is shown chips with a second criterion. With completion on second criterion the child is asked to do it with a third criterion and on not being able to do it him/herself, is shown a third criterion.

RULES FOR ASSESSMENT:

0 Figurative collection/Just one dimension with help and no further progress.
IA Just one dimension without help. No further progress. I
IB Second dimension with help. Inability to classify with a third dimension even after help.
2A Three dimensions with help at IB (It means that one dimension without help and two dimension with help). II
2B Two dimensions without help. III
2C Third dimension with help at 2B.
3 Three dimensions spontaniously.

Order of Dimensions

(Sh. C1. Sz.)

A: C1 Sh Sz (A1,A2,A3)
B: Sh C1 Sz (B1,B2,B3)
C: Sz C1 Sh/Sz Sh C1 (C1,C2,C3)

D: C1 Sz Sh (D1,D2,D3)
E: Sh Sz C1 (E1,D2,E3)

Labelling

a. Reference to the shape or some essential characteristics of the shape.
b. Some name lacking in essential reference to the shape.

Colour Naming

i. Correct.
ii. Incorrect.

10.CONCEPT OF TIME

MATERIAL:

One board with 2 roads. Small road 10 inches long and parallel to the board, large road 13 inches long on top of small road at 30 degree angle; Two toy cars.

PROCEDURE:

After familiarizing the child with material especially the lengths of the roads, he/she is told that the both cars travel with the same speed and stars from the same point. The questions are asked prior to movement and after movement as to which car will reach to its destination earlier. Then questions are asked that when the car on shorter road reaches to the end where the car on longer road would be. Then the child is told that noth car starts simultaneously and reach to their respective destinations simultaneously and questions are asked whether these will travel with the same speed or not.

RULES FOR ASSESSMENT:

1. Confusion of time, speed and distance in all situations.
2. Clarity in some situations and confusion in some other situations.
3. Clarity in all situations.

11.MOUNTAIN:

MATERIAL

A well formed mountain sketched(cyclostyled) on a paper and a red marker.

PROCEDURE:

The child is encouraged and helped in identifying the mountain. It is cheched if the child can draw a house and a tree. If the child hesitates or says that he/she cannot draw, he/she is helped to draw on the back of paper by showing simplest form of a house and a tree in drawing.

Then he/she is asked to draw a house and a tree on the mountain by pointing out at the mountain's outline. If horizontality is not clear enough in the first drawing the child is asked to draw on the other side of the mountain.

RULES FOR ASSESSMENT:

I.A: Drawings unrelated to the mountain.
I.B: Houses and trees are vertical to the top-line of the mountain.
2. Houses and trees starts shifting along the gravity. Some are true vertical and some vertical to the topline of the mountain. I
3. All the houses and trees are true vertical. II

12.PLUMB LINE:

MATERIAL:

Regeant bottle with a porous cork; Black piece of cord with a lead plumb on its end. The plumb line is fixed in the center of the cork.A set of five sketches showing the nottle in vertical straight, vertical inverted, side vise right titled straight and left titled inverted positions. The first sketch shows the plumb line in the bottle and the remaining skotches show empty bottles. All the sketches also show base line of the table.

PROCEDURE:

The child is familiarized with the material and is told that there is a weight hanging at the end of he black cord. He/she is also told about the base line of the tables He/she is shown first sketch with the plumb line already drawn in it. Then he/she is asked to draw the cord and the plumb line in all the subsequent positions of the bottle without allowing him/her to touch or move the bottle.

RULES FOR ASSESSMENT

1. The line is parallel to the side walls of the bottle. No awareness of gravity,
2. Begining of adjustments of movement of line with the position of the bottle. Awarness of gravity but lack of external reference in some situations. Line not lumped in the inverted bottle. I
3. Line lumped in the inverted bottle. Line vertical to the table base in all situations. External system of reference. II

13. CLASS INCLUSION:

MATERIAL:

Two Yellow plastic "gaindas" and seven red plastic roses.

PROCEDURE:

The child is encouraged and helped to name the set of flowers and sub sets of "gainda" and roses. He/She is also made to talk about general class of flowers containing various sub-classes. While keeping the bunch of roses in his own hand and showing it to the child, the experimenter makes the inquiry, However, when asking guestions about the largeness of class versus sub class (red roses) the experimenter removes the bunch from the child's visual field.

RULES FOR ASSESSMENT:

1. No understanding of class inclusion relations. Comparison between discrete sub-classes (Red versus Yellow) or horizontal comparison.
2. Beginning of inclusion relations. Some vertical comparisons between class and sub-classes. Understanding of inclusion in some situations but not generalized to all situations. I
3. Correct comparisons between sub-classes and class (vertical comparison) is all situations. II

14. PERSPECTIVE:

MATERIAL:

Sheet of a blank paper and a red marker.

PROCEDURE:

The child's imagination is invoked to look into a road while standing in the centre of that road and that the road is going far off into a distance and have tall trees on its both edges. On a blank sheet of paper the child is asked to imagine himself standing on the nottom of the page and looking upward into the road. A little sketch of a person is made on the bottom of the page in order to give definite frame of reference to child. Then he/ she is asked to draw up the road. After the child has drawn two lines of the road he/she is asked to draw trees o.. the both edges of the road going far into the distance.

RULES FOR ASSESSMENT:

1.A. No concept of perspective. Lines of road parrellel and tree vertical to the lines.
1.B. Tree drawn upright but no perspective in the road or trees. I
2.A. Receeding trees vertical to the road.
2.B. Perspective in the road but tree drawn of uniform size/receeding upright trees but no perspective of road. II
3. Full perspective. Inclination of the road lines in the distance, decreasing size of trees in the distance. III

Appendix 3B : Piagetian interview battery
(note by Dr M. Shayer)

Work on this battery is reported briefly in the end of grant report to the ESRC on the CASE project (June 1984), and in more detail in a monograph in process of revision for Genetic Psychology Monographs by Shayer, Demetriou and Pervez. The interview battery was developed for use in a Piagetian developmental survey of children of Primary school age in Pakistan in 1980 by a team led by Pervez, with the assistance as consultants of Kenneth Lovell, Michael Shayer and Sylvie Opper, who related the test protocol and success criteria given in Appendix 3A to the available replication literature. Pervez was in England at the time of the IE pre-rest: he and Shayer divided the labour on this. Shayer carried out the post-test alone.

At the time of the pre-test only the behavioural success criteria for each child on each task were recorded: the problem of their accurate scaling relative to each other was left till later. It was later shown that the relative level of tasks was consistent by comparing the Pakistan battery results with (a) data gathered on 6 to 8 year-olds by Demetriou both in Greece and Australia with a battery with some tasks in common, and (b) with the British results on 10 to 12 year-olds gathered during the CSMS survey both on Conservation tasks, Volume and Heaviness and on the Spatial relation task (Task 1), both reported in Shayer, Küchemann and Wylam in 1976. Data from all three surveys were pooled in arriving at the levels shown in Figure 1 , p.294.

The method of data-analysis used in scaling the tasks consisted, in its essentials, of assuming that there existed both a 'task-level' and a 'person-level' which was independent of the particular sample, and then estimating the levels by an interative process which was continued until both estimates became stable. The criterion for 'task-level' was that level at which 67% of persons succeeded on a task. The criterion for 'person-level' was the mid-point of the maximum task-levels on which the subject still succeeded on two out of three. In this way it could be checked whether a task-level was the same in the contexts of two different batteries of tasks, used on two quite different samples.

For the purposes of the post-test in the present study, four of the puils who had reached the ceiling of the original Pakistan battery were given some extra interview items taken from the Piagetian group-tests developed by the CSMS team, which had already been scaled, to test the possibility that they were begining to show formal operational thinking (3A). In fact, each of the four were at the 'concrete generalisation' level.

Appendix 3C : Mapping of Piagetian level onto 'Mental Age'

(note by Dr M. Shayer)

The definition of mental age utilised is that age at which just 50% of the population achieve the behavioural criterion in question.For the mapping three reference points were required: the age at which 50% of children begin to solve elementary concrete tasks of conservation of mass and classification by one salient variable (2A); the point where most of the schemata of classification and seriation are shown (2B, or mature concrete), and the point where nearly all concrete operational tasks are solved (2B/3A, or concrete generalisation).

The first point was taken from a survey of the best available studies compiled by Epstein (1979) for a Conference on assessment of cognitive development - six years,nine months. The second two were taken by interpolation of the developmental survey results reported by Shayer, Kuchemann and Wylam (1976). For these purposes the 2B and 2B/3A levels were taken from the results reported on the task, Volume and Heaviness, since this contained the conservations which featured prominently in the individual interview battery used in the present IE study as pre- and post-test. Since there was a sex differential on these measures, separate mental ages were calculated for boys and girls: Boys, 2B - 10/11; 2B/3A - 13/2; Girls, 2B - 11/8; 2B/3A - 14/8. This gave two virtually linear plots for mental age against Piagetian level, and the following regression equations were then used for the mapping of Piagetian level on the interview battery onto Mental Age :

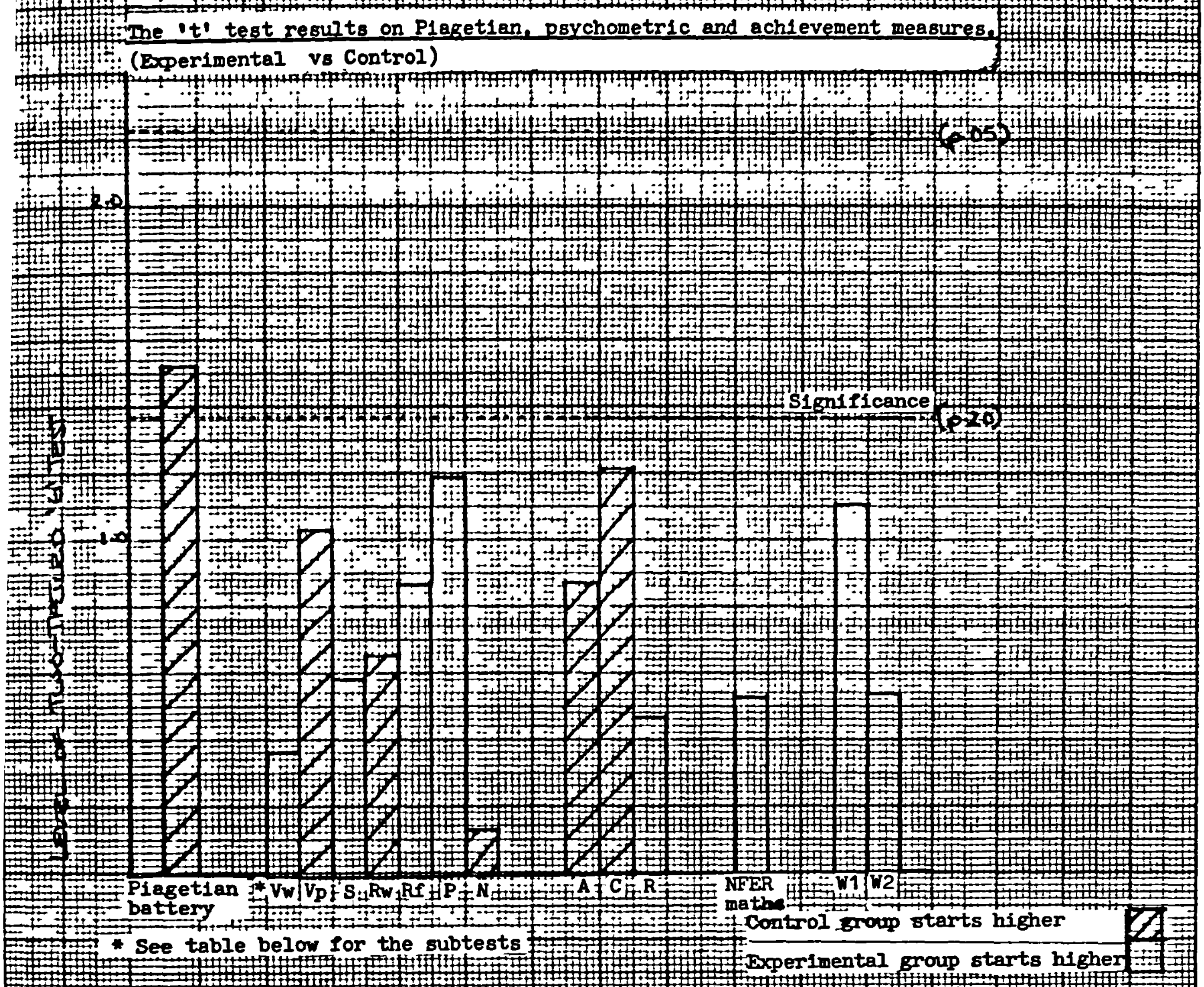
For Girls, $MA = 31.07 \times Level + 18.86$ months

For Boys, $MA = 25.59 \times Level + 29.82$ months .

The production of separate mental age estimates for boys and girls is not meant to pre-judge the issue of whether boys or girls show greater relative maturity in Piagetian terms.

For a formal operational task, Pendulum, girls and boys show almost identical mental ages. But for the purposes of a pre- and post-test, where the most important criterion is an accurate estimate of individual change, this was considered the soundest course.

Appendix 4A : The pre-test Piagetian, psychometric and achievement results



THE PRE-TEST RESULTS : Experimental vs. Control

Test	't'	Significance	SD difference*
Piagetian battery	-1.52	.20	-0.62
Thurstone's PMA			
Verbal-words (Vw)	0.36	ns	0.14
Verbal-pictures (Vp)	-1.03	ns	-0.42
Spatial (S)	0.58	ns	0.24
Reasoning-words (Rw)	-0.65	ns	-0.26
Reasoning-figures (Rf)	0.87	ns	0.36
Perception (P)	1.19	ns	0.49
Numbers (N)	-0.13	ns	-0.05
NEALE Analysis of reading			
Accuracy (A)	-0.87	ns	-0.37
Comprehension (C)	-1.22	ns	-0.50
Rate (R)	0.47	ns	0.19
NFER Mathematics attainment	0.53	ns	0.21
Richmond test of basic skills			
Map reading (W1)	1.11	ns	0.45
Reading graphs and tables (W2)	0.54	ns	0.23

* Difference between the means of the two groups (Standard deviations)

A negative result means that the experimental group starts from a lower position.

(N=12, with 10df).

Appendix 4B: The pre-test raw data for the Piagetian battery, Thurstone's PMA and tests of school achievement.

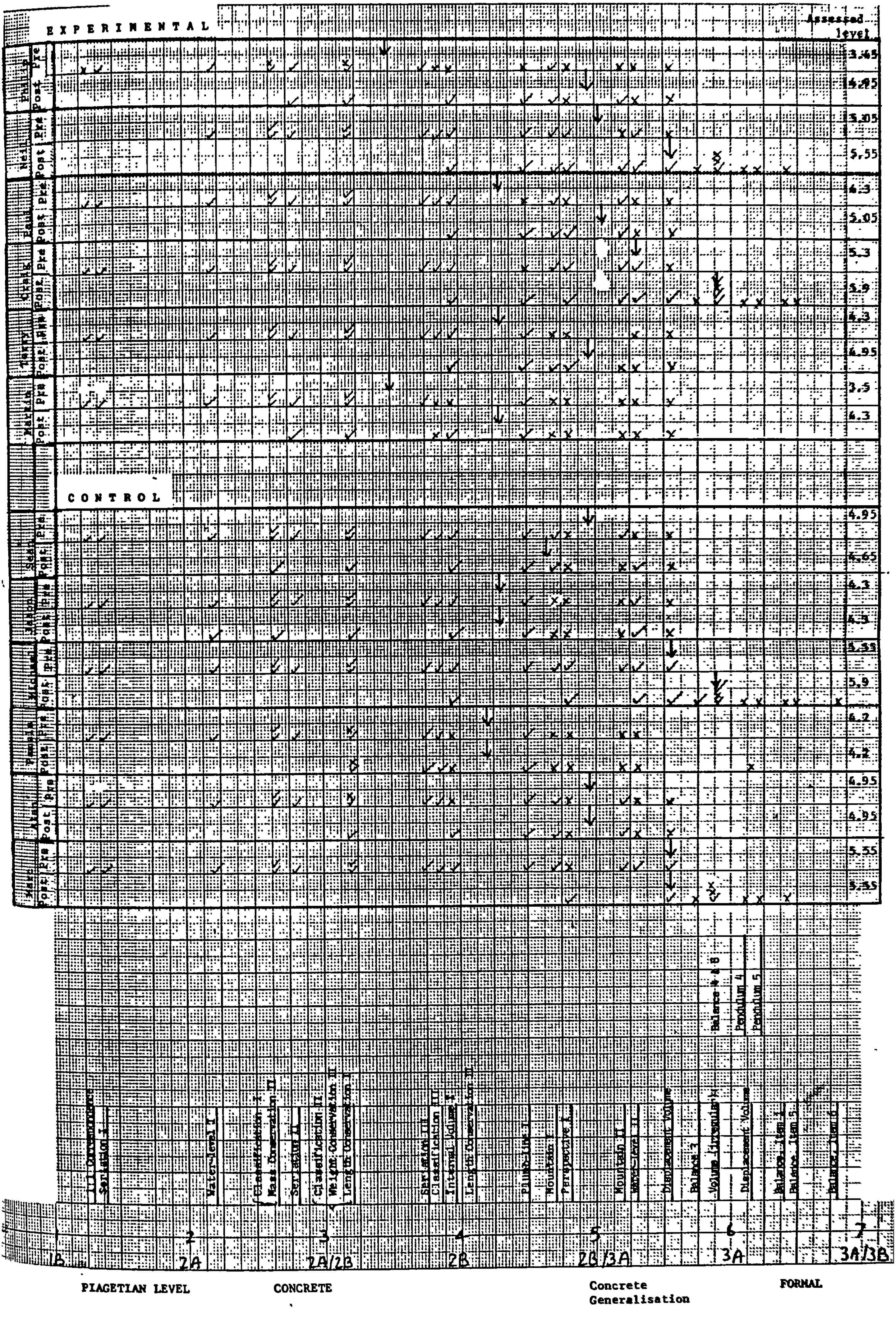
The Piagetian battery (Experimental & Control)
Tested October 1982.

	Piagetian Level	Mental Age
Experimental		
Philip D.	3.45	9.10
Neil F.	5.05	13.03
Paul G.	4.30	11.08
Craig J.	5.30	13.09
Terry M.	4.30	11.08
Martin T.	3.50	9.11
Control		
Sean C.	4.95	13.00
Jason G.	4.30	11.08
Michael K.	5.55	14.04
Pamela M.	4.20	12.05
Alan N.	4.95	13.00
Marc S.	5.55	14.04

The Piagetian Level is determined by the number of items which the subject successfuly completed, see Figure 1 overleaf, using the 2/3 success criterion outlined in Appendix 3B.

The Piagetian Level is converted into a Mental Age score using the regression equations provided in Appendix 3C.

FIGURE 1: PRE-POST TEST COMPARISON OF IE GROUP AND CONTROL ON BATTERY OF CONCRETE AND FORMAL TASKS



APPENDIX 4B : PRE-TEST RAW DATA

Thurstone PMA (Experimental & Control)
Tested October 1982

Subtest :	Vw	Vp	S	Rw	Rf	P	N
Raw score Mental Age % Correct	(/36)	(/37)	(/27)	(/27)	(/27)	(/50)	(/52)
Experimental							
Philip D. 19.7.70	26 11.06 72%	24 11.10 65%	14 9.02 52%	15 9.02 56%	18 10.02 67%	33 13.00 66%	36 10.10 69%
Neil F. 22.10.69	24 11.00 67%	25 12.00 68%	20 11.06 74%	16 9.06 59%	21 11.08 78%	35 13.06 70%	27 9.06 52%
Paul G. 15.4.70	20 10.04 56%	21 10.10 57%	12 8.00 44%	13 8.08 48%	13 7.08 48%	39 14+ 78%	27 9.06 52%
Craig J. 19.8.70	22 10.08 61%	25 12.00 68%	25 14.00 93%	17 9.10 63%	21 11.08 78%	35 13.06 70%	30 9.10 58%
Terry M. 8.5.70	22 10.08 61%	23 11.06 62%	13 8.08 48%	18 10.04 67%	22 12.02 81%	45 14+ 90%	24 9.02 46%
Martin T. 16.6.70	17 10.00 47%	20 10.06 54%	10 6.10 37%	13 8.08 48%	18 10.02 67%	21 9.10 42%	10 8.00 19%
Control							
Sean C. 4.4.70	21 10.06 58%	24 11.10 65%	13 8.08 48%	18 10.04 67%	15 8.08 56%	18 9.00 36%	31 10.00 60%
Jason G. 4.8.70	22 10.08 61%	28 13.00 76%	10 6.10 37%	12 8.06 44%	15 8.08 56%	21 9.10 42%	9 8.00 17%
Michael K. 10.7.70	21 10.06 58%	28 13.00 76%	21 12.00 78%	20 11.04 74%	24 13.02 89%	44 14+ 88%	28 9.06 54%
Pamela M. 31.12.69	15 9.08 42%	18 9.10 49%	10 6.10 37%	14 9.00 52%	16 9.02 59%	25 11.00 50%	33 10.04 63%
Alan N. 28.12.69	24 11.00 67%	24 11.10 65%	14 9.02 52%	19 10.10 70%	19 10.08 70%	33 13.00 66%	26 9.04 50%
Marc S. 27.3.70	24 11.00 67%	27 12.08 73%	16 10.00 59%	15 9.02 56%	13 7.08 48%	31 12.06 62%	31 10.00 60%

Pre-test raw data

NEALE analysis of reading (Experimental & control)
Tested October 1982

Raw Score Mental Age	Age	Accuracy	Comprehension	Rate
Experimental				
Philip D.	12.03	29 8.01	18 9.03	52 8.04
Neil F.	13.00	17 7.03	12 8.05	24 6.11
Paul G.	12.06	26 7.11	15 8.10	36 7.08
Craig J.	12.02	22 7.07	17 9.01	47 8.02
Terry M.	12.05	16 7.02	10 7.10	28 7.02
Martin T.	12.04	38 8.08	13 8.07	40 7.10
Control				
Sean C.	12.06	28 8.00	17 9.01	33 7.07
Jason G.	12.02	14 7.01	9 7.06	20 6.08
Michael K.	12.03	27 7.11	18 9.03	28 7.02
Pamela M.	12.10	41 8.10	20 9.06	58 8.07
Alan N.	12.10	34 8.06	23 10.05	42 7.11
Marc S.	12.07	30 8.02	15 8.10	26 7.01

Pre-test raw data

NFER Mathematics Attainment A, B, or C1 (Experimental & Control)
Tested October 1982
Results in terms of raw scores and mental ages.

	* Test A(/42)	Test B(/42)	Test C1(50)	Mental Age
Experimental				
Philip D.	23	15		8.07
Neil F.		20		8.10
Paul G.		18		8.05
Craig J.		23	17	9.04
Terry M.		18		8.05
Martin T.	19			8.02
Control				
Sean C.	17			7.10
Jason G.	13			7.04
Michael K.		25	16	9.08
Pamela M.	25	15		8.10
Alan N.	22	14		8.06
Marc S.		18		8.05

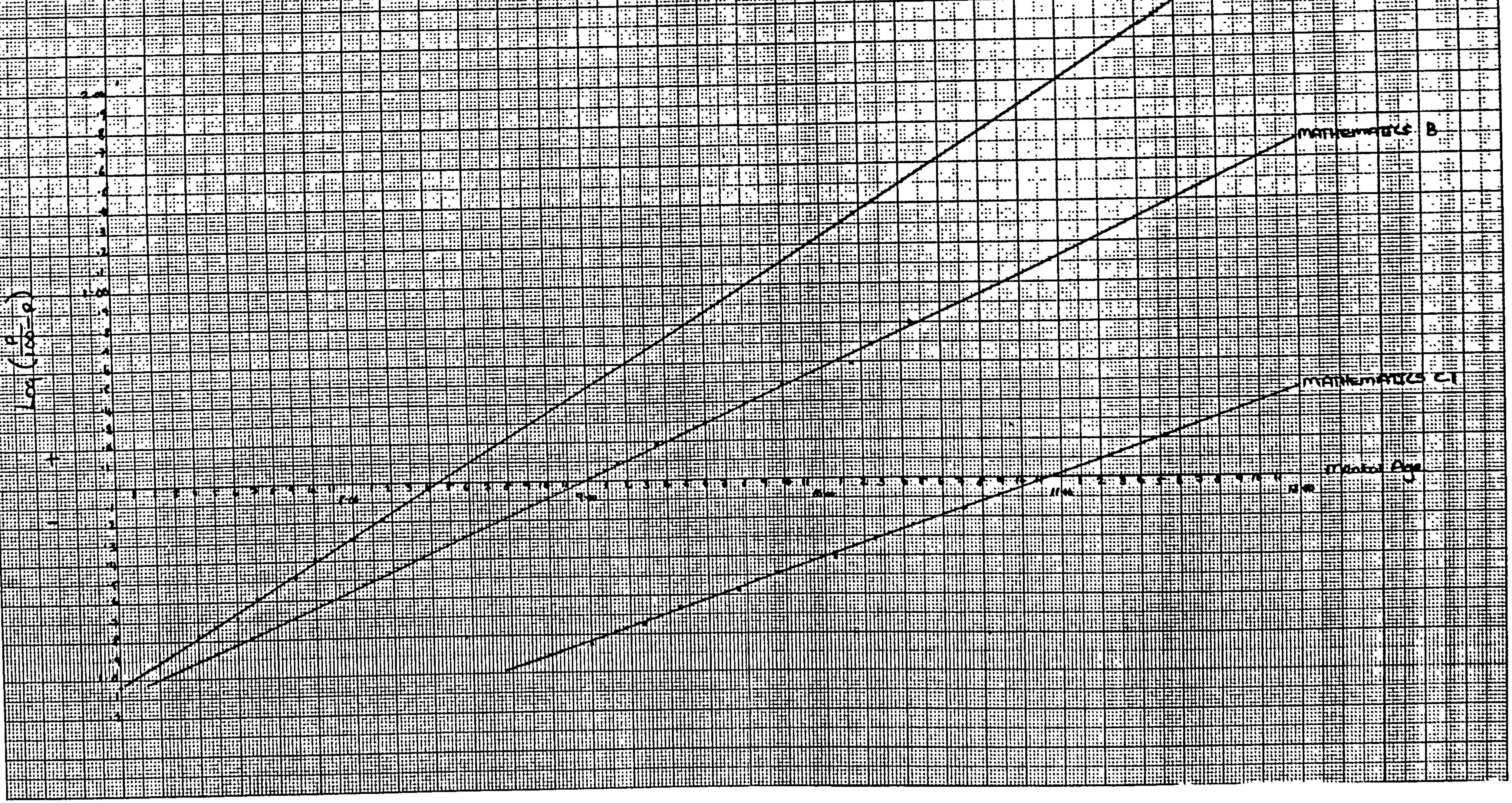
*Mathematics attainment tests A. B. or C1. were given in accordance with the class teacher's estimation of pupil ability. In cases of doubt, the adjacent tests were given and both raw scores were recorded. This allows for post-test improvements to show up in cases where the ceiling on the pre-test has been reached.

Unfortunately the NFER tests are not continuous, so that is possible to score above the ceiling on test A (8.06) but below the threshold on test B (8.00).

The mental age relating to a given raw score is obtained from the tables of norms in the NFER manuals of instruction, (NFER 1978). For tests B and C1 the third year norms have been used. A function of these, log(p/(100-p)), where p is the percentage of correct answers, is plotted on the graph overleaf for the mental age corresponding to standardised scores of 100. These lines have been extrapolated so that the scores relating to mental ages outside the ranges given in the manual may be read from the graph. Where adjacent tests have been given the highest mental age has been recorded.

A GRAPH SHOWING THE MENTAL AGES CORRESPONDING TO Log(p/(100-p)) FOR THE NFER MATHEMATICS ATTAINMENT TESTS A, B, AND C1

where p is the percentage of correct answers



Pre-test raw data

<u>Richmond test of basic skills (Experimental & Control)</u>
Tested October 1982

Subtest :	W1(/27)	W2(/20)
<u>Experimental</u>		
Philip D.	12	
Neil F.	6	10
Paul G.	10	11
Craig J.	12	10
Terry M.	10	15
Martin T.	15	9
<u>Control</u>		
Sean C.	12	5
Jason G.	9	5
Michael K.	13	16
Pamela M.	6	12
Alan N.	9	8
Marc S.	3	16

W1 is a test of map reading ability.
W2 tests the ability to read graphs and tables.

TABLE 1 (Appendix 4C)

Pre-test raw data
Evidence of 'deficient' cognitive functioning on the LPAD Variations.(Experimental & Control)

Cognitive function		Philip	Neil	Paul	Craig	Terry	Martin	Sean	Jason	Michael	Pamela	Alan	Marc
LABELS	▲	6	6	14	3	4	7	5	11	9	6	22	10
	A	3	10	2	2	8	7	6	2	6	9	0	1
	✓	13	5	6	9	8	6	12	5	5	7	1	10
(24)	E	2	3	2	10	4	4	1	6	4	2	1	3
Problem definition (24)	✓	0	0	0	0	0	0	0	0	0	0	0	0
Relevant cues (24)	✓	0	3	2	5	3	1	6	2	1	1	1	0
Impulsivity	✓	7	4	1	5	6	3	5	2	2	4	1	2
'checking'(24)	▲	0	2	2	1	2	1	2	0	3	2	1	3
Trial & error (24)	✓	0	0	0	0	0	1	2	0	0	0	0	0
Blocking (24)	✓	0	1	1	2	3	5	0	7	1	2	3	2
2 Sources	▲	12	16	11	14	16	10	14	13	22	15	11	20
(24)	✓	12	8	13	10	8	14	10	11	2	9	13	4
Hypoth. think.	▲	3	7	3	5	5	3	4	5	7	7	4	8
(8)	✓	5	1	5	3	3	5	4	3	1	1	4	0
Interioriz. (24)	✓	1	1	4	1	0	2	1	1	0	0	1	0
Episodic Grasp of reality (24)	✓	0	0	2	0	0	2	0	2	0	0	1	0
Logic	▲	13	21	13	13	13	9	16	18	21	20	14	17
(24)	✓	11	3	11	11	11	15	8	6	3	4	10	7
Egocentric(24)		0	0	3	0	4	3	2	1	0	1	1	4
Evidence	▲	9	10	3	9	5	5	10	6	10	13	8	8
	✓	7	11	12	6	16	6	5	12	12	7	6	10
(24)	E	8	3	9	9	3	13	9	6	2	4	10	6
Language	▲	8	9	6	7	4	2	0	6	8	10	6	3
	A	6	7	7	3	8	7	5	9	11	4	7	6
	✓	2	5	2	5	8	3	11	3	4	7	2	9
(24)	E	8	3	9	9	4	12	8	6	1	3	9	6

Experimental (Philip – Martin) Control (Sean – Marc)

▲= Good use of cognitive function
A= Adequate use
✓= Evidence for deficient cognitive function
E= Examiner supplied the answer

(24) Total number of questions; frequency data indicates the number of questions, out of 24, on which there was evidence recorded about the cognitive functions.

(8) Data specifically refering to the eight questions where the subjects were asked to predict the solutions of the matrix problems.

Table 2 (Appendix 4C)

Pre-test raw data

Mediation on the LPAD Variations items (Experimental & Control)

	EXPERIMENTAL						CONTROL					
	Philip	Neil	Paul	Craig	Terry	Martin	Sean	Jason	Michael	Pamela	Alan	Marc
AN	5	5	6	5	6	8	7	5	4	6	5	0
A1	7	0	7	4	0	0	6	0	0	0	1	1
A2	0	0	0	0	1	0	0	0	0	0	0	0
A3	8	4	7	0	6	6	8	6	4	0	4	0
A4	7	0	0	0	0	0	0	0	0	0	0	0
A5	4	6	0	0	0	8	0	3	0	0	0	0
A6	0	0	0	0	0	7	0	0	0	0	0	0
BN	5	4	8	5	6	8	5	9	5	8	0	0
B1	4	0	1	0	5	0	0	9	0	1	0	0
B2	0	0	0	0	0	6	0	8	4	1	8	0
B3	0	0	0	6	0	0	0	0	0	0	0	0
B4	0	0	0	0	0	0	0	0	0	0	7	0
B5	6	8	8	7	5	8	6	7	0	6	6	6
B6	6	0	8	5	6	4	5	7	0	4	5	6
CN	7	6	6	8	3	6	0	0	0	8	6	0
C1	7	4	0	0	0	8	0	0	0	0	6	0
C2	0	0	0	0	0	0	0	0	0	0	0	0
C3	7	4	0	0	5	0	0	8	6	0	9	0
C4	0	5	4	0	0	0	0	0	0	0	7	0
C5	6	4	9	4	2	8	0	6	0	4	8	0
C6	4	1	0	0	0	0	1	0	0	6	8	0
DN	4	0	5	0	0	0	0	1	0	0	4	0
D1	0	0	0	0	4	9	5	1	0	0	8	0
D2	0	0	4	8	7	9	3	7	0	0	8	4
D3	4	1	0	0	0	4	0	0	0	0	0	0
D4	6	4	0	0	6	0	4	7	0	0	0	7
D5	0	6	0	6	6	8	0	0	0	6	0	6
D6	0	0	9	5	0	4	0	8	0	0	0	0
EN	0	8	6	8	7	8	5	7	0	4	7	7
E1	9	0	7	0	0	4	0	8	0	0	0	0
E2	4	0	7	8	0	7	6	0	0	3	9	0
E3	0	4	8	0	4	7	7	0	0	0	4	0
E4	0	3	0	0	0	1	8	4	0	0	0	0
E5	0	0	0	0	4	0	6	0	0	0	0	0
E6	0	0	0	6	4	0	5	0	0	0	0	0

Appendix 4C Table 3

Pre-test raw data.

Frequency analysis of response patterns on the LPAD Variations (Experimental & Control)

Aspects of performance

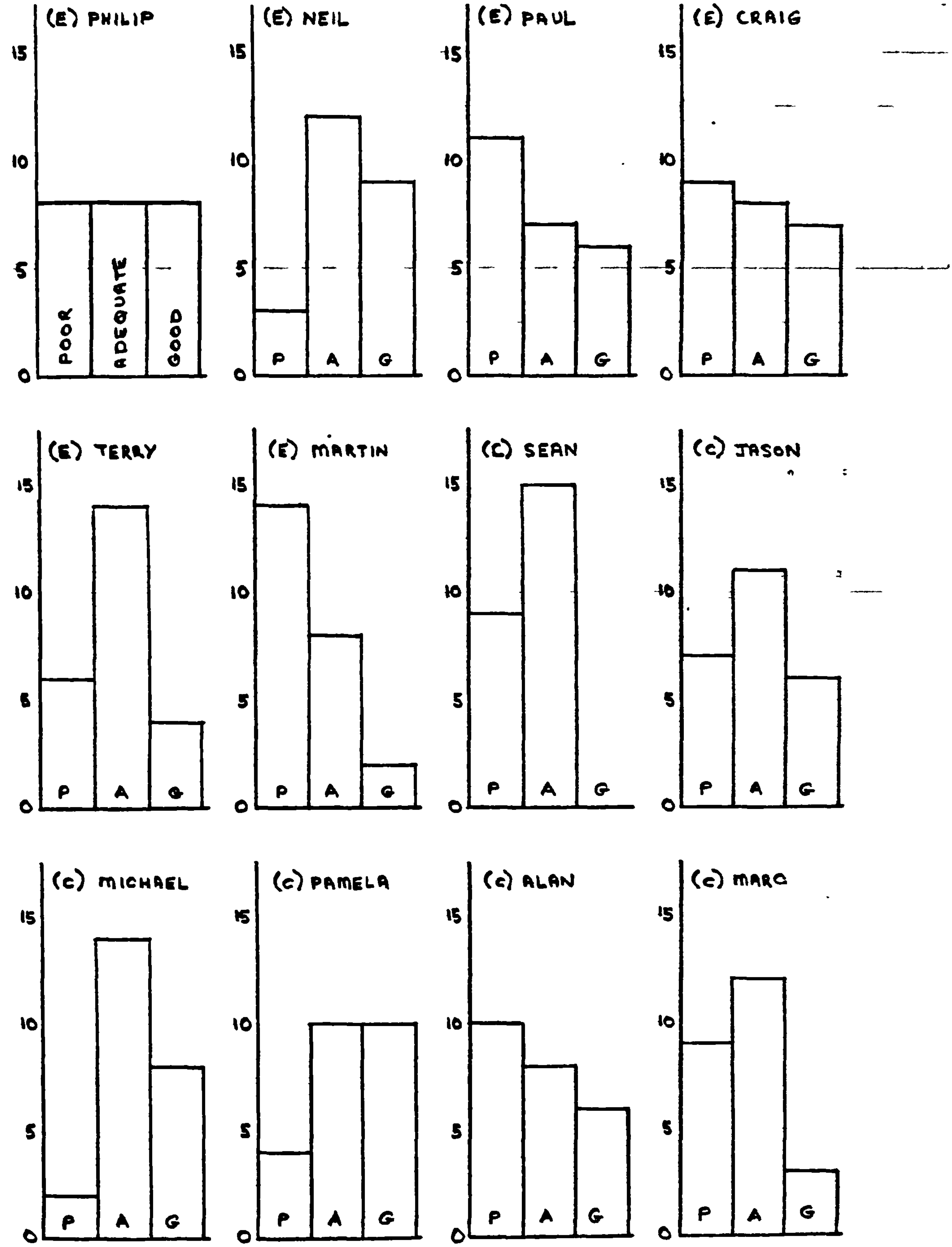
	Egocentric communication. /Language.				Logic. /Sufficient evidence.				Impulsivity errors / 2 sources of information			
1) Response patterns	E✓ E✓	- - ✓A	- ▲		∈ ∈ ∈ ✓	∈ ▲ ▲ ✓	▲ ▲		✓- ✓✓	✓ ▲	- ▲	
Weighting	2	1	0	*T.	2	1	0	T.	2	1	0	T.
Experimental												
Philip	8	8	8	24	10	6	8	26	12	3	9	27
Neil	3	12	9	18	3	11	10	17	8	3	13	19
Paul	11	7	6	29	11	10	3	32	13	2	9	28
Craig	9	8	7	26	10	6	8	26	10	3	11	23
Terry	6	14	4	26	10	10	4	30	8	5	11	21
Martin	14	8	2	36	15	4	5	34	14	2	8	30
Control												
Sean	9	15	0	33	8	6	10	22	11	3	10	25
Jason	7	11	6	25	6	12	6	24	11	2	11	24
Michael	2	14	8	18	3	11	10	17	2	2	20	6
Pamela	4	10	10	18	4	7	13	15	9	4	11	22
Alan	10	8	6	28	10	6	8	26	13	1	10	27
Marc	9	12	3	30	7	9	8	23	4	2	18	10

*Total score: The frequency of the observed pattern of response multiplied by the weighting. (The lower the total score the higher the quality of response).

▲ = Good use of cognitive function
A = Adequate use
✓ = Evidence for deficient cognitive function
∈ = Examiner supplied the answer
\- = No deficient functioning observed.

1) The response patterns are taken from the recording schedules.

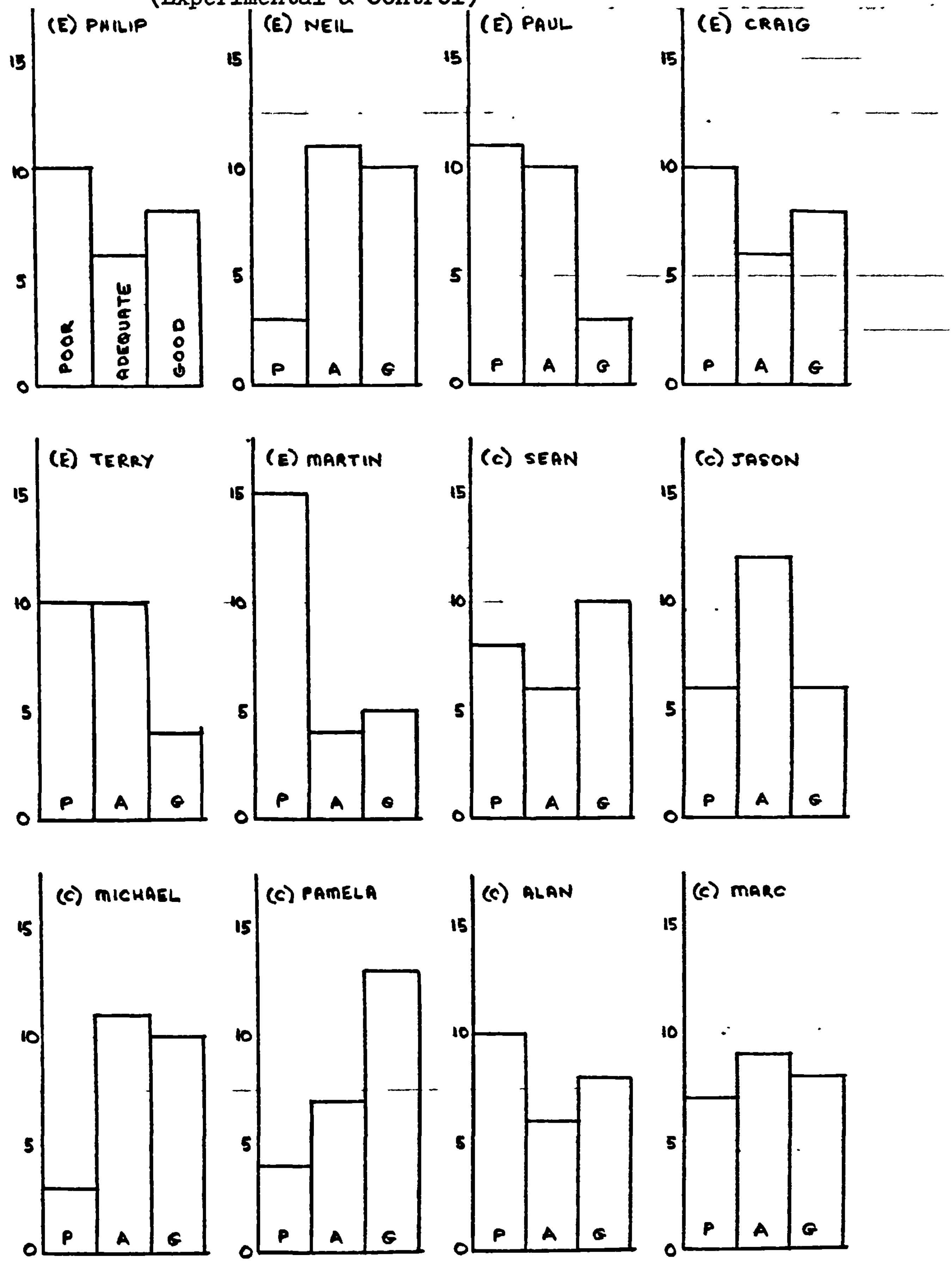
Figure 1 : Frequency analysis of response patterns with reference to the Egocentric communication / Language aspect of performance. (Experimental & Control)



This information is recorded on the schedules:

	Poor	Adequate	Good
Egocentric communication	E ✓	✓ A	▲

Figure 2 : <u>Frequency analysis of response patterns with reference to the Logic / Sufficient evidence aspect of performance.</u> (Experimental & Control)

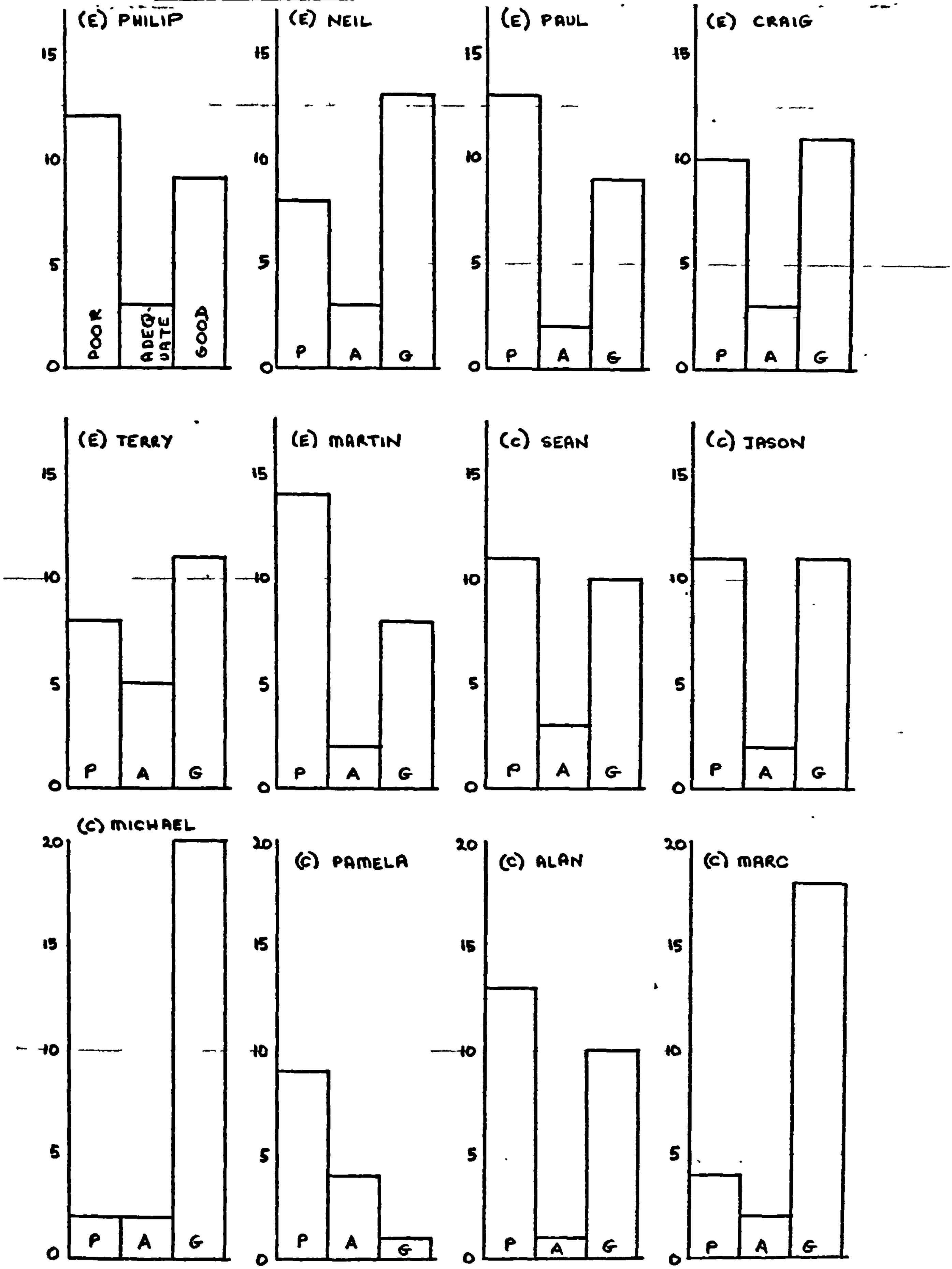


This is recorded on the schedules :

	Poor	Adequate	Good
Logic	EE	E▲	▲
Sufficient evidence	E✓	▲✓	▲

Appendix 4C (Pre-test raw data for the LPAD Variations)

Figure 3: <u>Frequency analysis of response patterns with reference to the Impulsivity / Two sources of information aspect of performance.</u> (Experimental & Control)



From the recording schedules Poor Adequate Good

Impulsivity related errors

Appendix 4C Table 4
(Pre-test raw data)

Evidence for 'deficient' cognitive functioning on the training page of the Representational Stencil Design Test
(Experimental & Control)

	Experimental						Control					
	Philip	Neil	Paul	Craig	Terry	Martin	Sean	Jason	Michael	Pamela	Alan	Marc
Problem definition	-	-	-	-	-	2	-	1	1	-	-	1
Relevant cues	1	2	1	1	2	4	2	2	1	1	2	2
Impulsivity	3	2	2	2	-	3	3	4	-	3	1	1
'checking'	1	1	6	-	-	-	3	-	1	3	-	1
Blurred perception	1	2	-	-	1	7	4	5	-	3	2	1
Precision and accuracy	2	1	2	1	1	9	3	2	1	3	4	-
Attention to sequence	2	1	4	1	-	9	3	2	-	2	6	1
Trial and error	-	-	-	-	-	-	-	-	-	-	-	-
Blocking	1	1	1	1	-	10	3	4	-	2	5	1
Hypothetical thinking	1	2	3	1	2	15	7	6	1	4	7	1
Interiorization	1	2	-	-	1	3	4	1	-	1	2	-
Episodic grasp of reality	-	1	2	-	-	6	-	3	1	2	4	-
Visual transport	-	-	2	-	-	2	-	-	-	2	1	-

'checking' occurs when the subject prevents his own impulsive response.

The data is in terms of the frequency of observed deficient functioning on the 20 training items.

Appendix 4C Table 5
(Pre-test raw data)

Evidence for 'deficient' cognitive functioning on the test page of the Representational Stencil Design Test

(Experimental & Control)

	Experimental						Control					
	Philip	Neil	Paul	Craig	Terry	Martin	Sean	Jason	Michael	Pamela	Alan	Marc
Number of test items completed :	17	12	12	20	17	3	9	9	20	12	6	17
Problem definition	-	-	-	-	-	-	-	-	-	-	-	-
Relevant cues	4	-	1	-	1	-	-	2	-	-	-	2
Impulsivity	6	2	3	-	3	1	1	-	3	2	-	3
'checking'	2	-	2	3	2	1	1	3	2	-	-	-
Blurred perception	1	4	2	-	-	1	1	-	-	2	-	1
Precision and accuracy	6	3	3	8	7	1	-	4	6	2	2	6
Attention to sequence	3	3	4	-	2	-	1	4	1	2	2	1
Trial and error	3	1	1	-	-	-	-	-	-	-	-	-
Blocking	-	-	2	6	-	1	1	2	2	3	1	8
Hypothetical thinking	4	4	4	5	4	1	1	4	4	4	3	6
Interiorization	3	3	-	-	-	-	1	1	1	1	-	2
Episodic grasp of reality	2	-	1	2	1	1	1	2	-	1	-	4
Visual transport	-	1	1	-	-	-	-	-	-	1	-	-

'checking' occurs when the subject prevents his own impulsive response

The data is given in terms of the frequency of observed deficient functioning up to the item on which the test was terminated.

Appendix 4C Figure 4
(Pre-test raw data)

Recording schedule for RSDT

Name : MARTIN

Training page

RSDT item :	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Problem definition	✓	✓																		
Relevant cues	✓	✓															✓			✓
Impulsivity									✓			✓		✓						
Blurred perception			✓						✓	✓				✓		✓			✓	✓
Precision and accuracy	✓	✓		✓		✓										✓	✓	✓	✓	✓
Attention to sequence			✓	✓	✓	✓							✓	✓		✓	✓	✓		
Trial and error																				
Blocking	✓	✓	✓		✓	✓										✓	✓	✓	✓	✓
Hypothetical thinking	✓	✓	✓	✓	✓	✓			✓	✓			✓	✓		✓	✓	✓	✓	✓
Interiorization	✓													✓			✓			
Episodic grasp of reality	✓	✓												✓		✓	✓			✓
Visual transport												✓	✓							
MEDIATION LEVEL :	10	9	8	7	8	8	0	0	7	8	0	1	8	9	0	10	10	9	8	10

Test page

RSDT item :	1	2	3	4	5	7	6	9	12	10	8	14	11	13	15	16	17	18	19	20
Problem definition																				
Relevant cues																				
Impulsivity		ch																		
Blurred perception																				
Precision and accuracy																				
Attention to sequence																				
Trial and error																				
Blocking		✓																		
Hypothetical thinking																				
Interiorization																				
Episodic grasp of reality																				
Visual transport																				
MEDIATION LEVEL :	0	4	0																	

ch = checking (which occurs when the subject prevents his own impulsive response).
✓ = evidence for deficient cognitive function

Appendix 4C Figure 5
(Pre-test raw data)

Recording schedule for RSDT

Name : PAMELA

	Training page																				Test page												cut-off							
RSDT item :	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	7	6	9	12	10	8	14	11	13	15	16	17	18	19	20
Problem definition																																								
Relevant cues																				✓																				
Impulsivity			ch	✓								ch	✓				✓	ch													✓	✓	✓							
Blurred perception												✓					✓			✓											✓	✓	✓							
Precision and accuracy														✓				✓	✓											✓	✓		✓							
Attention to sequence		✓												✓																✓	✓		✓							
Trial and error																																								
Blocking																		✓		✓								✓		✓	✓		✓							
Hypothetical thinking														✓				✓	✓	✓								✓		✓	✓	✓	✓							
Interiorization																				✓											✓		✓							
Episodic grasp of reality														✓						✓											✓		✓							
Visual transport				✓									✓																			✓								
MEDIATION LEVEL :	0	4	0	4	0	0	0	0	0	0	0	1	1	9	0	0	4	8	4	9	0	0	0	0	0	0	0	7	0	7	9	6	10							

ch = checking (which occurs when the subject prevents his own impulsive response).

✓ = evidence for deficient cognitive function

Appendix 4C Figure 6
(Pre-test raw data)

Recording schedule for RSDT

Name : MICHAEL

Training page

RSDT item :	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Problem definition																				✓
Relevant cues																				✓
Impulsivity																ch				
Blurred perception																				
Precision and accuracy	✓																			
Attention to sequence																				
Trial and error																				
Blocking																				
Hypothetical thinking																				✓
Interiorization																				
Episodic grasp of reality																				✓
Visual transport																				
MEDIATION LEVEL :	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9

Test page

RSDT item :	1	2	3	4	5	7	6	9	12	10	8	14	11	13	15	16	17	18	19	20
Problem definition																				
Relevant cues																				
Impulsivity							ch					ch			✓		✓	✓		
Blurred perception																				
Precision and accuracy								✓					✓		✓		✓	✓		✓
Attention to sequence							✓													
Trial and error																				
Blocking								✓									✓			
Hypothetical thinking								✓									✓	✓		✓
Interiorization																		✓		
Episodic grasp of reality																				
Visual transport																				
MEDIATION LEVEL :	0	0	0	0	0	0	0	7	0	0	0	0	4	0	4	0	7	8	0	7

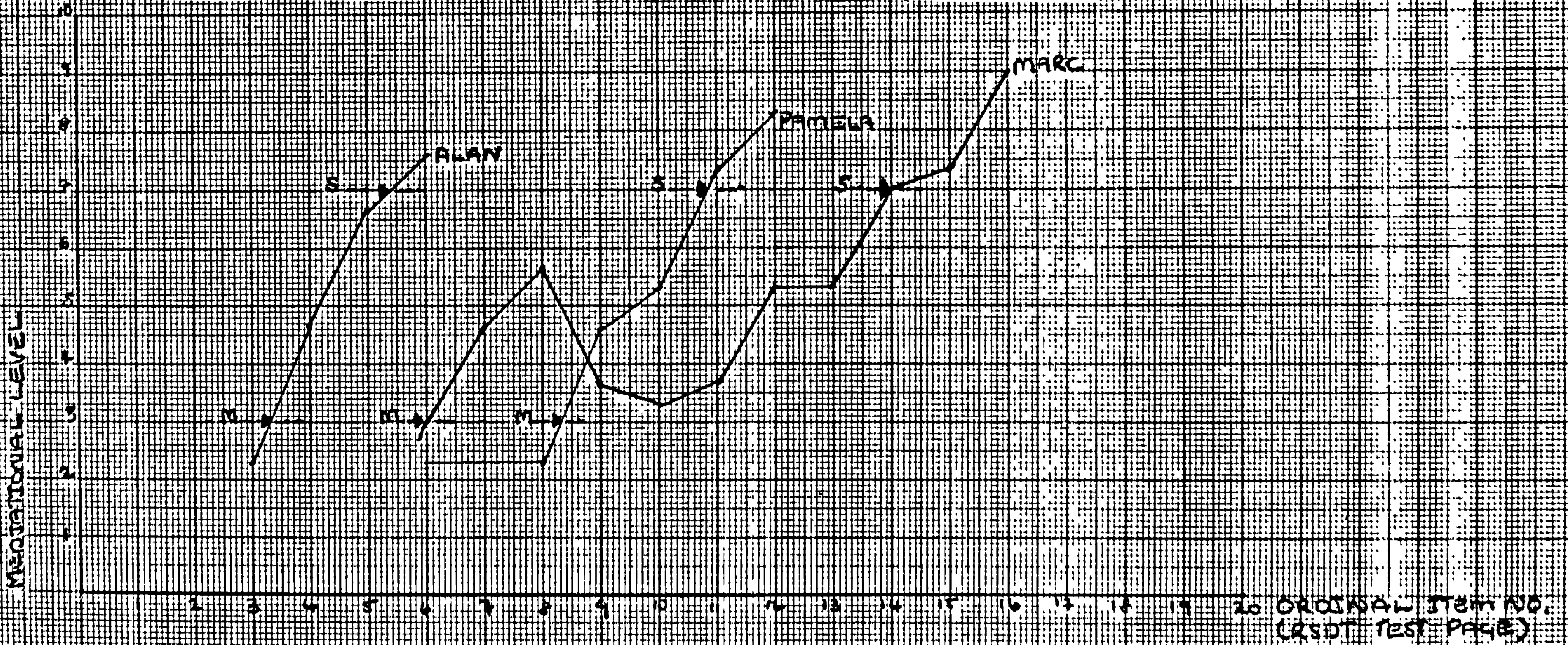
ch = checking (which occurs when the subject prevents his own impulsive response).
✓ = evidence for deficient cognitive function

Appendix 4C (Pre-test results)

Figure 7 : Examples of 'running mean' mediation scores for RSDT

(Running mean of the amount of mediation offered on three successive items)

S=A substantial amount of mediation (Level 7)
M=A moderate amount of mediation (Level 3)
S minus M gives an indication of 'modifiability'.The larger the difference the greater the estimate of 'modifiability'.



Appendix 4C : Figure 8

Decision criteria for establishing the level of unassisted success and the points of moderate and substantial mediation on the RSDT test items.

Unassisted success

This refers to the number of items solved successively without assistance prior to any mediation offered by the examiner. These scores are taken from the raw mediation scores,(See Appendix 4C, Table 6).

If the subject is able to solve at least three additional items without assistance, after the first intervention by the examiner, then these items can be added to the unassisted total.

Moderate mediation

Moderate mediation refers to the ordinal number of the test item where an average of level 3 assistance, from the 10 point mediational hierarchy scale, was first given. These figures can be read from a graph which plots a 'running mean' of the amount of mediation offered on three successive items,(See Figure 7, Appendix 4C, for examples).

If the running mean mediation subsequently drops below level three, for a larger number of items than were recorded above it, then moderate mediation is taken as the second point where level three assistance was required.

Substantial mediation

Is the point where the subject needs an average of level seven assistance or above.(See Figure 7, Appendix 4C).

If the mediation level subsequently drops below level seven then substantial mediation is taken as the second point where level seven assistance was required. For unattempted items a maximum mediation score of ten is assumed.

Appendix 4C Table 6
(Pre-test raw data)

Mediation on the Representational Stencil Design Test items (Experimental & Control)

Training page

Item no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Experimental																				
Philip	4	0	0	1	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	8
Neil	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	9	0	0	7
Paul	0	0	0	5	0	0	0	0	0	0	0	0	1	9	0	9	0	0	0	8
Craig	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4	0	0	6
Terry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	1	8
Martin	10	9	8	7	8	8	0	0	7	8	0	1	8	9	0	10	10	9	8	10
Control																				
Sean	6	8	7	8	0	0	0	0	0	0	0	0	8	0	0	0	8	4	0	7
Jason	8	8	1	0	6	0	0	0	0	0	0	0	0	0	0	9	9	4	3	10
Michael	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
Pamela	0	4	0	4	0	0	0	0	0	0	0	1	1	9	0	0	4	8	4	9
Alan	8	9	3	4	7	0	0	0	0	0	0	0	0	1	0	10	9	9	4	8
Marc	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8

Test page

Item no.	1	2	3	4	5	7	6	9	12	10	8	14	11	13	15	16	17	18	19	20
Experimental																				
Philip	0	0	0	0	0	0	4	0	8	5	0	0	5	9	7	4	9			
Neil	0	0	0	0	0	0	5	8	1	7	6	7								
Paul	0	0	0	8	0	0	1	7	0	10	8	5								
Craig	0	0	0	0	0	0	0	8	0	8	1	0	4	3	9	4	0	4	9	8
Terry	0	0	0	0	0	0	0	0	4	4	4	6	6	9	0	4	7			
Martin	0	4	0																	
Control																				
Sean	0	0	0	0	0	0	0	9	6											
Jason	0	0	0	5	9	3	7	9	0											
Michael	0	0	0	0	0	0	0	7	0	0	0	0	4	0	4	0	7	8	0	7
Pamela	0	0	0	0	0	0	0	7	0	7	9	6								
Alan	0	0	0	7	7	6														
Marc	0	0	0	0	0	0	9	5	3	3	4	4	8	4	9	9	9			

Mediation refers to the amount of assistance, on a 10 point scale, offered to the individual to enable him to solve the test item.

Appendix 5: The post-test raw data for the Piagetian battery Thurstone's PMA and tests of school achievement.

The Piagetian battery (Experimental & Control)
Tested May 1984.

	Piagetian Level	Mental Age
Experimental		
Philip D.	4.95	13.00
Neil F.	5.55	14.04
Paul G.	5.05	13.03
Craig J.	5.90	15.01
Terry M.	4.95	13.00
Martin T.	4.30	11.08
Control		
Sean C.	4.65	12.05
Jason G.	4.30	11.08
Michael K.	5.90	15.01
Pamela M.	4.20	12.05
Alan N.	4.95	13.00
Marc S.	5.55	14.04

The Piagetian level is determined by the number of items which the subject successfuly completed, using the 2/3 success criterion outlined in Appendix 3B .The actual items which the pupils attempted have been reported for both pre- and post-test in Figure 1,Appendix 4B.

The Piagetian Level is converted into a Mental Age score using the regression equations provided in Appendix 3C.

Post-test raw data

Thurstone PMA (Experimental & Control)
Tested May 1984

Subtest : Raw score Mental Age	Vw (/36)	Vp (/37)	S (/27)	Rw (/27)	Rf (/27)	P (/50)	N (/52)
Experimental							
Philip D.	32 13.02 89%	28 13.00 76%	15 9.08 56%	15 9.02 56%	22 12.02 81%	18 9.00 36%	33 10.04 63%
Neil F.	26 11.06 72%	25 12.00 68%	22 12.06 81%	19 10.10 70%	20 11.02 74%	45 14+ 90%	28 9.06 54%
Paul G.	19 10.04 53%	20 10.06 54%	12 8.00 44%	16 9.06 59%	20 11.02 74%	42 14+ 84%	35 10.08 67%
Craig J.	27 11.08 75%	28 13.00 76%	25 14+ 93%	19 10.10 70%	20 11.02 74%	31 12.06 62%	30 9.10 58%
Terry M.	27 11.08 75%	23 11.06 62%	16 10.00 59%	18 10.04 67%	22 12.02 81%	38 14+ 76%	24 9.02 46%
Martin T.	26 11.06 72%	18 9.10 49%	15 9.08 56%	17 9.10 63%	18 10.02 67%	17 8.10 34%	28 9.06 54%
Control							
Sean C.	26 11.06 72%	18 9.10 49%	11 7.06 41%	14 9.00 52%	15 8.08 56%	28 11.10 56%	27 9.06 52%
Jason G.	23 10.10 64%	29 13.04 78%	9 6.04 33%	10 8.02 37%	16 9.02 59%	22 10.00 44%	20 8.10 38%
Michael K.	32 13.02 89%	30 13.08 81%	21 12.00 78%	22 12.08 81%	23 12.08 85%	42 14+ 84%	36 10.10 69%
Pamela M.	23 10.10 64%	23 11.06 62%	13 8.08 48%	14 9.00 52%	13 7.08 48%	23 10.04 46%	33 10.04 63%
Alan N.	26 11.06 72%	25 12.00 68%	13 8.08 48%	18 10.04 67%	25 13.08 93%	31 12.06 62%	34 10.06 65%
Marc S.	32 13.02 89%	28 13.00 76%	21 12.00 78%	16 9.06 59%	25 13.08 93%	29 12.00 58%	29 9.08 56%

Post-test raw data

NEALE analysis of reading (Experimental & Control)
Tested May 1984

	Accuracy	Comprehension	Rate
Raw score Mental Age			
Experimental			
Philip D.	46 9.01	31 11.08	80 9.11
Neil F.	21 7.06	18 9.03	50 8.03
Paul G.	33 8.05	18 9.03	52 8.04
Craig J.	24 7.09	17 9.01	56 8.06
Terry M.	27 7.11	16 8.11	64 8.11
Martin T.	44 9.00	17 9.01	72 9.04
Control			
Sean C.	36 8.07	20 9.06	58 8.07
Jason G.	21 7.06	15 8.10	28 7.02
Michael K.	34 8.06	25 10.10	42 7.11
Pamela M.	42 8.10	25 10.10	73 9.04
Alan N.	34 8.06	21 9.10	60 8.09
Marc S.	35 8.06	21 9.10	59 8.08

Post-test raw data

NFER Mathematics Attainment A, B, or C1 (Experimental & Control

Tested May 1984

Results in terms of raw scores and mental ages.

	*Test A(/42)	Test B(/42)	Test C1(/50)	Mental Age
Experimental				
Philip D.	30	20		9.07
Neil F.		24		9.06
Paul G.		20		8.10
Craig J.		32	28	11.06
Terry M.		22		9.02
Martin T.	28	14		9.03
Control				
Sean C.	21			8.04
Jason G.	17			7.10
Michael K.		34	29	11.08
Pamela M.	30	19		9.07
Alan N.	31	17		9.08
Marc S.		20		8.10

* The mental age scores have been obtained in exactly the same way as on the pre-test, refer to Appendix 4B.

Post-test raw data

<u>Richmond test of basic skills</u> (Experimental & Control)
Tested May 1984

Subtest :	W1(/27)	W2(/20)
<u>Experimental</u>		
Philip D.	16	9
Neil F.	18	17
Paul G.	14	11
Craig J.	19	16
Terry M.	18	14
Martin T.	22	12
<u>Control</u>		
Sean C	14	11
Jason G.	11	8
Michael K.	22	18
Pamela M.	13	10
Alan N.	9	9
Marc S.	13	14

W1 is a test of map reading ability.
W2 tests the ability to read graphs and tables.

Appendix 6 : Post-test raw data for the LPAD tests

Table 1

Post-test gain scoes on Raven's matrices (Experimental & Control)
Tested May 1984

Name	Age *y.m.	Total score (1)	(2)	gain	Mental age (1)	(2)	gain *y.m.	Percentile point (1)	(2)	gain
Exp.										
Philip	13.10	27	33	6	8.01	9.03	1.02	3	7	4
Neil	14.07	35	40	5	9.06	11.00	1.06	8	15	7
Paul	14.01	29	34	5	8.03	9.04	1.01	3	8	5
Craig	13.09	48	49	1	14.06	14.06	0	66	71	5
Terry	14.00	32	45	13	9.00	13.05	4.05	6	45	39
Martin	13.11	31	38	7	8.05	10.00	1.05	5	14	9
Control										
Sean	14.01	31	39	8	8.06	10.00	1.06	5	16	11
Jason	13.09	26	36	10	8.00	9.08	1.08	3	11	8
Michael	13.10	44	48	4	13.01	14.06	1.05	40	66	22
Pamela	14.05	29	38	9	8.03	10.00	1.09	2	13	11
Alan	14.05	36	41	5	9.08	12.00	2.04	10	20	10
Marc	14.02	26	28	4	8.00	8.02	.02	2	2	0

* years and months

(1) first administration of Raven's matrices

(2) second administration of the matrices, given after assistance on the LPAD Variations.

gain = the difference between (1) and (2).

Appendix 6

Table 2: Post-test mediation on the LPAD Variations items (Experimental & Control)

	Experimental						Control					
	Philip	Neil	Paul	Craig	Terry	Martin	Sean	Jason	Michael	Pamela	Alan	Marc
AN	9	6	6	0	6	9	0	6	0	6	6	0
A1	0	1	0	1	0	0	0	0	0	0	0	1
A2	0	0	0	0	0	0	0	3	0	0	0	0
A3	0	0	0	0	0	8	1	0	0	0	0	0
A4	0	0	0	0	0	4	0	0	0	0	0	0
A5	0	0	4	0	0	10	0	0	0	6	0	0
A6	1	0	0	0	2	0	0	4	0	0	0	0
BN	6	4	8	0	0	6	4	8	4	6	0	0
B1	3	0	0	0	0	4	4	2	0	9	0	1
B2	0	0	6	0	0	8	0	8	0	7	0	0
B3	0	0	0	0	0	0	0	0	0	0	0	0
B4	6	0	4	0	0	4	0	0	0	4	0	0
B5	6	6	6	6	7	0	9	7	6	8	6	7
B6	6	4	4	0	0	0	6	4	0	0	6	1
CN	6	6	8	4	6	7	0	0	0	0	4	0
C1	0	0	0	0	0	5	0	0	0	0	0	0
C2	0	0	0	0	0	0	0	0	0	0	0	0
C3	0	0	0	0	0	0	6	0	0	6	0	0
C4	0	0	0	0	0	0	0	0	0	0	0	0
C5	1	0	6	0	0	0	0	0	0	0	6	0
C6	4	0	0	0	0	0	3	0	0	0	0	0
DN	0	0	2	0	0	0	0	0	0	0	0	0
D1	0	0	0	1	0	0	0	0	0	0	2	4
D2	0	6	2	6	0	4	8	7	6	6	7	0
D3	0	0	0	0	0	0	4	0	0	6	0	0
D4	4	0	4	0	1	4	0	7	0	0	0	0
D5	0	0	6	0	4	7	6	4	0	1	0	4
D6	0	0	8	1	0	8	4	4	0	0	0	4
EN	8	6	8	6	7	6	7	8	1	6	0	6
E1	7	3	6	0	0	0	9	0	0	0	0	0
E2	7	1	6	0	0	0	0	4	0	10	0	0
E3	4	0	8	0	0	6	4	0	0	9	0	6
E4	0	0	3	6	0	4	8	0	0	8	0	0
E5	6	0	0	0	1	0	4	0	0	0	0	4
E6	6	0	0	0	0	4	0	0	0	7	0	0

Appendix 6 (Post-test raw data)

Table 3 : Frequency analysis of response patterns on the LPAD Variations

Aspects of performance

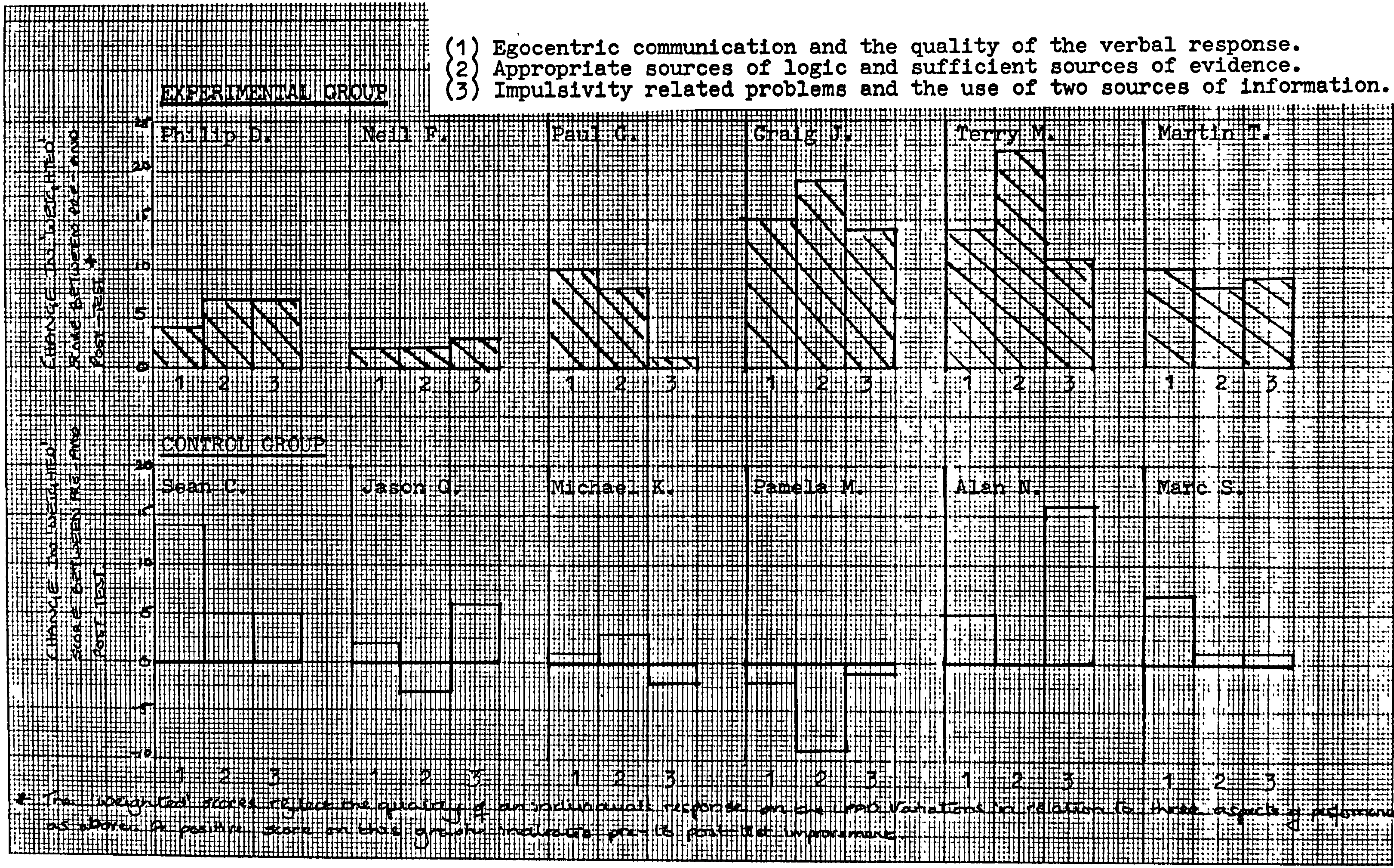
	Egocentric communication. /Language.				Logic. /Sufficient evidence.				Impulsivity errors. / 2 Sources of information.			
1) Response Patterns	E ✓ E ✓	- - ✓A	- ▲		E E E✓	E ▲ ▲ ✓	▲ ▲		✓- ✓✓	✓ ▲	- ▲	
Weighting	2	1	0	*T	2	1	0	T	2	1	0	T
Experimental												
Philip D.	3	14	7	20	6	7	11	19	8	4	12	20
Neil F.	3	10	11	16	4	7	13	15	6	4	14	16
Paul G.	3	13	8	19	7	10	7	24	13	1	10	27
Craig J.	1	9	14	11	1	5	18	7	3	3	18	9
Terry M.	1	10	13	12	2	4	18	8	4	1	19	9
Martin T.	6	14	4	26	9	8	7	26	9	3	12	21
Control												
Sean C.	5	9	10	19	7	3	14	17	7	6	11	20
Jason G.	6	11	7	23	8	11	5	27	6	6	12	18
Michael K.	2	13	9	17	3	8	13	14	2	4	18	8
Pamela M.	5	10	9	20	8	8	8	24	11	1	12	23
Alan N.	7	9	8	23	8	10	6	26	5	1	18	11
Marc S.	4	15	5	23	4	14	6	22	3	3	18	9

1) The response patterns are taken from the recording schedules.

*T Total score: The frequency of the observed pattern of response multiplied by the weighting. (The lower the total score the higher the quality of response).

▲= Good use of cognitive function
A = Adequate use
✓= Evidence for deficient cognitive function
E = Examiner supplied the answer

Figure 1 : Pre- to post-test change in 'weighted' scores, in relation to three aspects of performance, plotted for individuals in the experimental and control groups.



Appendix 6 (post-test raw-data)

Table 4A: Evidence of 'deficient' cognitive functioning on the LPAD Variations for individuals in the experimental and control groups. (Post-test)

		EXPERIMENTAL GROUP						CONTROL GROUP					
Cognitive function		Philip	Neil	Paul	Craig	Terry	Martin	Sean	Jason	Michael	Pamela	Alan	Marc
Labels	▲	5	14	5	11	10	6	10	13	13	4	13	5
	A	11	3	11	8	5	3	3	4	4	9	5	5
	✓	4	3	3	3	4	6	2	3	2	5	4	11
(24)	E	4	4	5	2	5	9	9	4	5	6	2	3
Problem definition (24	✓	0	0	0	0	0	0	0	0	0	0	0	0
Relevant cues (24)	✓	3	1	2	1	1	2	3	1	0	1	1	1
Impulsivity	✓	4	5	3	4	2	3	7	6	2	1	2	3
'checking' (24)	▲	0	2	1	2	1	1	1	0	3	0	0	1
Trial and error (24)	✓	0	0	2	1	0	0	3	1	0	3	0	2
Blocking (24)	✓	7	0	6	2	2	2	5	7	1	4	0	2
2 Sources.	▲	16	18	13	21	20	15	17	18	22	13	19	21
(24)	✓	8	6	11	3	4	9	7	6	2	11	5	3
Hypoth. thinking	▲	5	8	6	8	8	5	6	6	8	6	8	8
(8)	✓	3	0	2	0	0	3	2	2	0	2	0	0
Interiorization (24)	✓	0	0	0	0	0	0	0	1	0	2	0	0
Episodic grasp of reality (24)	✓	1	0	0	0	0	1	2	0	0	4	0	0
Logic	▲	18	20	15	22	21	15	17	16	21	16	16	21
(24)	✓	6	4	9	2	3	9	7	8	3	8	8	3
Egocentric (24)	✓	0	0	0	0	0	1	1	0	0	0	0	0
Evidence	▲	11	13	9	18	19	7	14	5	13	8	6	6
	✓	10	8	12	5	4	11	5	13	9	11	11	14
(24)	E	3	3	3	1	1	6	5	6	2	5	7	4
Language	▲	7	11	8	14	13	4	10	7	9	9	8	5
	A	9	6	8	8	3	11	6	9	8	8	7	9
	✓	5	4	5	1	7	3	3	2	5	2	2	6
(24)	E	3	3	3	1	1	6	5	6	2	5	7	4

▲ = Good use of cognitive function
A = Adequate use
✓ = Evidence for deficient cognitive function
E = Examiner supplied the answer

(24) Total number of questions; frequency data indicates the number of questions, out of 24, on which there was evidence recorded about the cognitive functions.
(8) Data specifically refering to the eight questio where the subject was asked to predict the solutions of the matrix problems.

Table 4B : Pre- to post-test improvements in the use of cognitive functions on the LPAD Variations for individuals in the experimental and control groups.

functions* :	labels	rel. cues	Impuls-ivity	trial& error	block.	2 sources of info.	Hypoth. think.	int.	EGR	logic	ego. comm.	Suffic. evid.	lang.
Experimental													
Philip	6	-3	3	0	-7	4	2	1	-1	5	0	7	1
Neil	9	2	-1	0	1	2	1	1	0	-1	0	3	3
Paul	-9	0	-2	-2	-5	2	3	4	2	2	3	12	5
Craig	22	4	1	-1	0	7	3	1	0	9	0	17	19
Terry	9	2	4	0	1	4	3	0	0	8	4	16	13
Martin	-6	-1	0	1	3	5	2	2	1	6	2	9	8
Control													
Sean	7	3	-2	-1	-5	3	2	1	-2	1	1	8	21
Jason	6	1	-4	-1	0	5	1	0	2	-2	1	-1	2
Michael	6	1	0	0	0	0	1	0	0	0	0	3	-1
Pamela	-4	0	3	-3	-2	-2	-1	-2	-4	-4	1	-6	2
Alan	-13	0	-1	0	3	8	4	1	1	2	1	1	4
Marc	-6	-1	-1	-2	0	1	0	0	0	4	4	0	7

*See Table 4A for the cognitive 'deficiencies'. NB no observations of 'problem definition' were made on either the pre- or post-test therefore it has not been included on the list of improvements.

A negative score means the post-test performance was lower than the pre-test. The observations in this table refer to pre- to post-test improvements ie a decrease in the observed frequency of 'deficient' cognitive functions or an increase in positive use of these functions. See the details in the text, Chapter 6, for how these differences were calculated where there was more than one type of information (positive and negative) for a particular cognitive function.

Appendix 6

Table 5 : Post-test estimates of 'modifiability' using RSDT (Experimental & Control)

Ordinal number of items successfully completed :

	Unassisted success.	Moderate mediation Level 3.	Substantial mediation Level 7.	Difference 7-3	Unassisted competence. *(1)	'Modifiability' estimate. *(2)
Experimental						
Philip	6	7	17.5	10.5	Medium	High
Neil	7	11.5	18.25	6.75	Medium	High
Paul	3	9.5	13.25	3.75	Low	Medium
Craig	12	18	19.5	1.5	High	Low
Terry	11	12.25	17	4.75	High	Medium
Martin	3	3.5	7.25	3.75	Low	Medium
Control						
Sean	6	7	9.25	2.25	Medium	Low
Jason	6	11.75	13	1.25	Medium	Low
Michael	14	ceiling	ceiling	-	High	(Ceiling effect)
Pamela	7	7.25	17	9.75	Medium	High
Alan	6	6.5	10.5	4	Medium	Medium
Marc	6	6.75	17.5	10.75	Medium	High

*(1) Unassisted competence
Low = 0-3 items
Medium = 4-8 items
High = 9+ items

*(2) 'Modifiability' estimate
Low A difference of less than 3 items
Medium A difference of between 3-5 items
High A difference of above 6 items

Appendix 6

Table 6 : The difference between the post-test and pre-test results on the RSDT measures of 'modifiability' for individuals in the experimental and control groups.
(Post minus pre)

	Unassisted success	Moderate mediation Level 3	Substantial mediation Level 7	Difference 7-3
Experimental				
Philip	0	-0.5	1.25	1.75
Neil	1	5.25	7	1.75
Paul	0	0.75	2.75	1.5
Craig	5	9.75	0.5	-9.25
Terry	3	3	0	-3
Martin	2	1	3.25	2.25
Control				
Sean	-1	0	0.75	0.75
Jason	3	8.25	3	-5.25
Michael	3	*	*	*
Pamela	0	-1	6.25	7.25
Alan	3	3.25	5	1.75
Marc	0	0.75	3.5	2.75

A negative score on the number of items successfully completed with moderate and substantial help(and the difference between the two) means that the subject made less gains as a result of assistance on the post-test than was made on the pre-test.

*Since Michael's post-test scores reached the 'ceiling' the difference between the number of items 'completed' at pre and post-test could not be calculated. However, he obtained three more items correct, without assistance, than he had done on the pre-test.

Appendix 6

Table 7 : Post-test mediation scores on the Representational Stencil Design Test items (Experimental & Control)

	Training page																				Test page																			
Item no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	7	6	9	12	10	8	14	11	13	15	16	17	18	19	20
Experimental																																								
Philip	1	0	0	0	0	0	0	0	0	0	0	0	0	6	0	5	0	0	6	3	0	0	0	0	0	0	4	5	8	5	1	7	6	7	7	4	4			
Neil	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	3	0	4	7	8	4	4	4	7	9	8
Paul	0	0	0	0	0	0	4	0	0	1	0	0	0	6	0	0	9	5	5	6	0	0	0	9	5	0	8	0	0	7	4	1	10	9	5	9	8			
Craig	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	7	0	4	0	0	8	8
Terry	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	6	0	0	0	0	0	0	6	0	0	0	0	0	6	9	5	3	8			
Martin	8	7	4	0	2	0	0	0	0	0	0	0	0	5	0	9	9	8	4	10	0	0	0	4	9	2	9	9	6											
Control																																								
Sean	5	0	0	0	0	0	0	2	1	0	0	0	0	5	0	0	6	0	1	10	0	0	0	0	0	0	8	1	8											
Jason	1	0	0	0	0	0	0	0	0	0	0	0	2	6	0	0	6	0	3	10	0	0	0	6	0	0	0	9	0	4	0	0	10	10	10	8	9			
Michael	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	4	0	0	4	1
Pamela	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0	10	0	0	0	0	0	0	0	8	4	10	4	0	9	10	0	4	8			
Alan	4	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	0	0	0	9	0	0	0	0	0	0	4	8	0	9	9	8								
Marc	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	6	0	0	0	0	0	0	4	6	0	5	6	0	6	5	8	1	6			

Mediation refers to the amount of assistance, on a 10 point scale, offered to the individual to enable him to solve the test item.

Appendix 6

Table 8 : Evidence for 'deficient' cognitive functioning on the training page of the Representational Stencil Design Test for individuals in the experimental and control groups. (post-test)

	Experimental						Control					
	Philip	Neil	Paul	Craig	Terry	Martin	Sean	Jason	Michael	Pamela	Alan	Marc
Problem definition	0	0	0	0	0	1	1	0	0	0	0	0
Relevant cues	0	0	2	0	0	4	1	1	0	1	2	0
Impulsivity	1	0	2	0	1	1	2	2	2	1	1	2
'checking'	0	2	0	0	2	1	1	0	0	0	0	2
Blurred perception	0	0	2	0	0	2	3	2	0	1	0	0
Precision and accuracy	3	0	2	0	0	6	0	1	0	1	1	0
Attention to sequence	3	1	3	0	1	4	3	1	1	2	1	1
Trial and error	0	0	0	0	0	0	0	0	0	0	0	0
Blocking	1	0	1	0	1	5	2	3	0	0	2	1
Hypothetical thinking	3	0	3	0	1	6	2	3	0	1	2	1
Interiorization	0	0	2	0	0	1	0	0	0	2	1	0
Episodic grasp of reality	0	0	1	0	0	3	1	1	0	1	1	0
Visual transport	1	0	0	0	0	0	0	1	2	1	1	0

'checking' occurs when the subject prevents his own impulsive response.

The data is in terms of the frequency of observed deficient functioning on the 20 training items.

Appendix 6

Table 9 : Evidence for 'deficient' cognitive functioning on the test page of the Representational Stencil Design Test for individuals in the experimental and control groups. (Post-test)

	Experimental						Control					
	Philip	Neil	Paul	Craig	Terry	Martin	Sean	Jason	Michael	Pamela	Alan	Marc
Number of items completed :	17	20	17	20	17	9	9	17	20	17	12	17
Problem definition	0	0	0	0	0	0	0	0	0	0	0	0
Relevant cues	0	0	1	0	0	0	1	0+3	0	0	0+1	0
Impulsivity	3	1+1	1+2	1	0	0+1	2	0+4	1	1+1	0+2	0
'checking'	1	0+3	1+2	1	2	0+1	1	1	2	0	0	3
Blurred perception	1	0+1	0	1	1	0	1	0	0	0	0+1	0
Precision and accuracy	8	3+6	1+3	5	6	0+4	1	2+5	3	3+3	0+3	7
Attention to sequence	3	0+4	4+3	0	1	0+5	0	1+2	1	1+2	0+4	0
Trial and error	0	0	0	0	0	0	0	0	0	0	0	0
Blocking	5	0+2	5+3	2	2	0+4	2	1+6	0	3+2	0+3	4
Hypothetical thinking	5	0+5	3+4	3	4	0+3	2	1+5	0	2+3	0+4	5
Interioriz-ation	1	0	3	1	0	0+2	0	0+1	0	0+1	0	0
Episodic grasp of reality	0	0+1	1+3	0	1	0+2	0	1+4	0	1+2	0+2	0
Visual transport	1	0	0	0	0	0	0	0	0	0	0+1	0

'checking' occurs when the subject prevents his own impulsive response.

The data is given in terms of the frequency of observed deficient functioning up to the item on which the test was terminated.

Where additional figures are given (+) these refer to the frequency of observed deficient functioning for items that had not been attempted on the pre-test.

Appendix 7 : Statistical tests conducted on the LPAD Variations

(1) The difference between the 'mean differences' for the improvements in the use of the cognitive functions by experimental and control subjects

In order to carry out a Scheffé or a Newman-Keuls test to find out whether the sub-test(cognitive functions) differences should be regarded as different, or only as small-sample variations around a common mean, it is first necessary to carry out a two-factor analysis of variance with repeated measures (Winer p.305-310). Since the test column variances are well outside the F-test for homogeneity, (Appendix 6,Table 4B), each sub-test set of scores for experimental and control subjects were first converted to standard scores to equalise the variances between the columns. Although this procedure has eliminated the large differences between the sub-tests, it still allows an estimate to be made of the Mean Square of sub-test x subjects within groups. The analysis of variance table is:

Source of variation	SS	df	MS	F
Between subjects				
Between groups	13.90	1	13.90	5.56 (4.96 for p. = .05)
Subjects within groups	25.02	10	2.50	
Within subjects				
Between sub-tests	0			
Interaction	7.53	12	0.63	0.78
Sub-tests x subjects within groups	96.46	120	0.80	

The standard error of the means within the 'tests' factor is given by:

$$(MS_{error} / 2 \times 6)^{\frac{1}{2}} = (0.80 / 2 \times 6)^{\frac{1}{2}}$$

However, here we wish to test the differences between the experimental and control group means, so by McNemar, p.116, the required standard error of differences is :

$$\left(\frac{0.80}{2 \times 6} + \frac{0.80}{2 \times 6}\right)^{\frac{1}{2}} = 0.365 .$$

For use of the Scheffé test we need compute (Mcnemar p.324)

$$K = (12 \times F_{.05}(12,60))^{\frac{1}{2}} = (12 \times 1.92)^{\frac{1}{2}} = 4.8$$

The difference, D, between one mean and the mean of all the other mean differences / standard error of the difference needs to exceed this value to be considered as significantly different from the other parts of the test.

The largest mean difference, b_{12} ('sufficient evidence') is 1.40; the mean of all the others is 0.53.

Hence $D / s_e = 1.4 - 0.53 / 0.365 = \underline{2.38}$.

The smallest mean difference is -0.16 with a mean of all the others of 0.66 .

Hence $D / s_e = 0.66 - (-0.16) / 0.365 = \underline{2.52}$.

Therefore the Scheffé test suggests that all the mean differences should be considered as variations around a common mean.

As a check the more powerful Newman-Keuls test,(which has the same critical value, 4.8, for testing the differences between the means having the largest difference between each other as the Scheffé), gives for the difference between the largest and smallest mean differences :

$$1.40 - (-0.16) / 0.365 = 1.56 / 0.365 = \underline{4.3}.$$

Thus both of these tests recommend that the sub-test mean differences are simply averaged to obtain an estimate of the experimental / control mean differences which have already been shown to be significantly different.

Appendix 7 (2) : The reliability of the LPAD Variations test

During the clinical interview which forms this part of the LPAD testing 13 cognitive functions are observed by the administrator; in the form of either adequate or inadequate usage of the functions on the part of the subject. These observations can be regarded as a 13 sub-test battery.

The internal consistency can be computed by analysis of variance. On the pre-test the experimental and control samples were combined :

Source of variation	SS	df	MS
Between people	435.7	11	39.6
Within people	17671.2	144	122.7
Between tasks	15940.1	12	1328.3
Residual (error)	1731.1	132	13.11

$$r_{tt} = \frac{39.6 - 13.11}{39.6} = \underline{0.67}$$

For the post-test, separate estimates were calculated for experimental and control groups.

Experimental ANOVA table

Source of variation	SS	df	MS
Between people	277	5	55.4
Within people	12808	72	177.9
Between tasks	12395	12	1033.0
Residual	413	60	6.88

$$r_{tt} = \frac{55.4 - 6.88}{55.4} = \underline{0.88}$$

Control ANOVA table

Source of variation	SS	df	MS
Between people	117	5	23.4
Within people	11195	72	155.5
Between tasks	10591	12	882.6
Residual	487	60	8.12

cont.

control ANOVA cont. (Appendix 7,2)

$$r_{tt} = \frac{23.4 - 8.12}{23.4} = \underline{0.65}$$

Appendix 7 (3) : Reliability of the difference scores pre- to post-test

ANOVA table, experimental group only

Source of variation	SS	df	MS
Between people	300	5	60.0
Within people	1846.9	72	25.7
Between tasks	871.1	12	72.6
Residual	976.1	60	16.27

$$r_{dd} = \frac{60 - 16.27}{60} = 0.73$$

(The reliability of the difference scores was computed directly from the values given in Table 4B, Appendix 6).

The corresponding reliability of the difference scores for the control group was calculated directly from the pre- and post-test variances, correlation and pre- and post-test reliabilities (McNemar, p.174).

This gave :
$$r_{dd} = \frac{486.3(1 - 0.67) + 303\ (1 - 0.65)}{486.3 + 303 - 2 \times 0.57 \times \sqrt{303} \times \sqrt{486.3}}$$
$$= \underline{0.24}$$